EO 75-10-2

ROYAL CANADIAN AIR FORCE

DESCRIPTION AND MAINTENANCE INSTRUCTIONS

ANTI-FRICTION BEARINGS

ISSUED ON AUTHORITY OF THE CHIEF OF THE AIR STAFF

22 FEB 57

LIST OF RCAF REVISIONS

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SECTION I

INTRODUCTION ON BALL AND ROLLER BEARING MAINTENANCE

I. Introduction on Ball and Roller Bearing Maintenance.

1. The following information is to outline a procedure for establishing a ball and roller bearing maintenance department at each Air Service Command Depot. The functions of the bearing maintenance department is to coordinate the cleaning, rework, inspection, installation and handling of bearings for aircraft, aircraft engine and accessories used by the Army Air Forces, except instrument and bombsight bearings.

2. At the present time there is no uniform method of cleaning bearings for reuse in our aircraft machinery. Consequently, many bearings are rejected for further use, which, if properly cleaned, could be utilized to great advantage, not only from the economical point of view but also from the point of view of conservation of vital war material. The problem of ball and roller bearing maintenance is pertinent to the war effort. It is not logical to assume that our present method of handling the bearings is practical because there is the matter of our rejecting many valuable bearings which could be serviceable by reclamation. This is sufficient emphasis for a more controlled method of maintenance on anti-friction bearings. The following data represents an anticipated requirement for establishing bearing maintenance and at the same time sets forth a definite policy to be followed in this work.

SECTION II

FACILITIES

II. Facilities.

1. Bearing maintenance departments will be established in each Air Service Command Depot to handle the cleaning, rework, inspection and maintenance of all bearings with the exception of instrument and bombsight items. As nearly as it is possible to ascertain at this time the following facilities will be required:

a. Area. The ideal floor space required for bearing maintenance is approximately 4000 to 5000 square feet, based on a maintenance of 3000 bearings per day and should be divided approximately into the following areas:

(1) Office - 20' x 20'.

(2) Receiving Area - 20' x 30'.

(3) Cleaning Room - 22' x 50'.

(4) Segregation and Visual Inspection Area - 20' x 30'.

(5) Rework Room - 27' x 38'.

(6) Final Inspection Area - 23' x 40'.

(7) Protection and Wrapping Area - 27' x 38'.

(8) Local Issue Area - 20' x 30'.

b. Location. The area will be made available as near to the department which utilized in the greatest degree the bearing maintenance facilities. No new building will be required to accomplish this work.

c. General Characteristics:

(1) Area should have good lighting.

(2) Rooms will be painted white.

(3) Area should be air conditioned.

(4) Area should have a minimum ceiling height of 10 feet.

(5) The cleaning and rework rooms will be equipped with proper ventilation to evacuate fumes and foreign matter. These rooms should incorporate air connections having 40 to 80 p.s.i. and circuits of 110 volts and 220 volts.

d. This area will be fire proofed and few windows and doors should be incorporated.

e. Cleanliness of Rooms. Every effort will be made at all times to maintain absolute cleanliness throughout the entire area. Personnel should be informed that it will be their duty to keep their work benches and surrounding area clean and orderly. All rags which are dirty and not being used will be placed in proper containers as outlined in local regulations. The importance of having the bearing shop in utmost cleanliness at all times cannot be overemphasized.

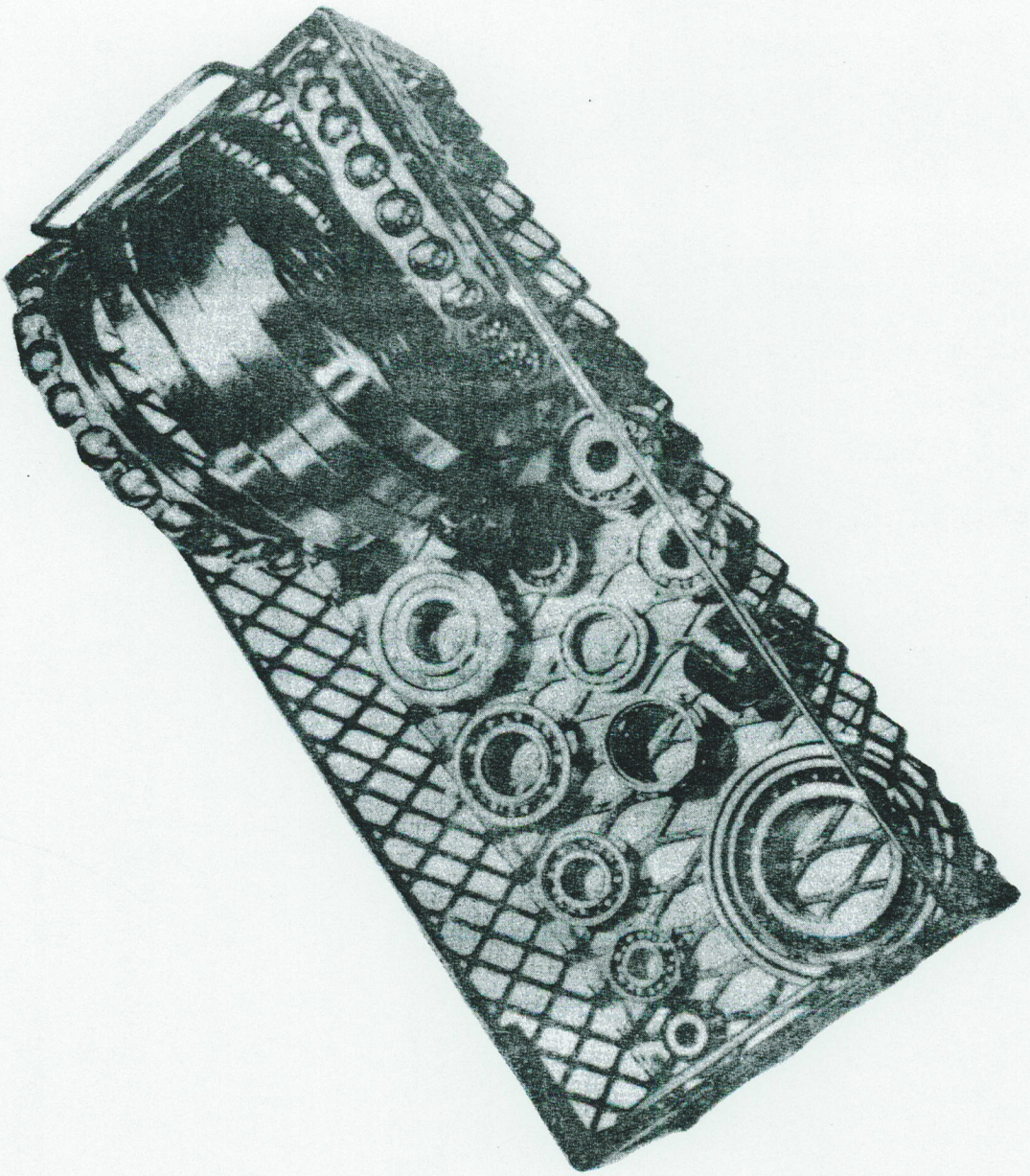


FIGURE 8

Bearings Neatly Arranged for Washing and Rinsing

SECTION III

FUNCTIONS OF BALL AND ROLLER

BEARING MAINTENANCE DEPARTMENT

III. Functions of Ball and Roller Bearing Maintenance Departments

1. To clean, rework, inspect, reoil, grease, and mark all bearings.

a. All bearings will be removed from equipment to be overhauled and will be sent direct to the bearing maintenance department in appropriate containers in order that the proper cleaning, rework, inspection, oiling and rewrapping can be accomplished.

b. All new bearings which have broken packages or which have been subjected to abuse will be processed through the bearing department for inspection and rewrapping.

SECTION IV

GENERAL INSTRUCTIONS

IV. General Instructions:

1. Final decision on a bearing's serviceability will be made by the bearing maintenance department. Once the bearing leaves the bearing maintenance department it will not be rejected unless by the mechanic during the installation of the bearing and this will only apply if the bearing was abused intransit.

2. Sub-assemblies containing anti-friction bearings which cannot be practicably removed from a component part should be sent to the bearing maintenance unit for processing as an assembly.

3. It is not intended to tear down any bearings in order to actually regrind the raceways.

4. It is not necessary to reinstall anti-friction bearings back into the same piece of equipment from which they were removed for bearing maintenance.

5. After bearings have been processed by the bearing maintenance department they will be placed in local issue which will be set up as part of the bearing department.

SECTION V

PERSONNEL

V. Personnel.

1. One of the most important factors with regard to this department is the assignment of trained personnel to supervise, rework and inspect bearings as they are processed.

2. Training facilities will be established to instruct such personnel. Since there is no exact mechanical means of determing the serviceability of anti-friction bearings, a serviceable bearing will be that bearing which an individual can visually inspect and pronounce as being serviceable. Certain mechanical tests can be made in addition to the visual inspection. Practical technique in handling and inspecting bearings, together with a training program, will make it possible for an inspector to render accurate decisions on the actual condition of the bearings.

3. Tentative lists and assignments for personnel in order to process 3000 bearings per an 8 hour shift. (Use as guide only.)

a. 1 Foreman - Supervisor.

b. 1 Jr. Stenographer - Office.

c. 1 Clerk - Office.

d. 1 Aircraft Mechanics' Helper - Operate Degreaser.

e. 1 Aircraft Mechanics' Helper - Operate Demagnetizer.

f. 7 Aircraft Mechanics' Helpers - Operate Cleaners.

g. 1 Jr. Aircraft Mechanic - Operate Cleaners.

h. 4 Aircraft Mechanics' Helpers - Disassembly.

i. 6 Jr. Aircraft Mechanics - Rework.

j. 1 Sr. Inspector.

k. 2 Journeymen Inspectors.

l. 7 Jr. Inspectors.

m. 4 Aircraft Mechanics' Helpers - Identifying and Wrapping.

n. 2 Jr. Aircraft Mechanics - Identifying and Wrapping.

4. Men or women personnel can be employed in these respective positions with the exception of the personnel in the cleaning and rework rooms. Men should be assigned to the duties in these rooms.

SECTION VI

HEARINGS TO BE PROCESSED

VI. Bearings to be Processed.

1. It is estimated that approximately 3000 bearings per day will be processed by each bearing maintenance department and that bearings out of the following equipment will be processed:

a. Engines.

b. Superchargers.

c. Generators.

d. Starters.

e. Pumps and Governors.

f. Equipment.

g. Wheels.

h. Motors. - Retracting and Actuating.

i. Miscellaneous.

j. Aircraft and Control Bearings.

2. In addition to the bearings coming from the various pieces of equipment, it is also estimated that a certain portion of bearings in backlog can be handled in order that the many bearings now in warehouses can be utilized to complete serviceable equipment. This data is sufficiently diversified in order to permit an increase or decrease in production without jeopardizing the efficiency of the department.

3. The "Standard Procedure of Bearing Flow to and from the Bearing Branch as shown of page (1b) is the method of routing bearings to be processed by the Bearing Branch.

a. All accumulated and back log bearings will be held in Reparable Warehouse until released by Production Control.

4. All bearings which have been rejected by the Bearing Branch inspectors will be oiled in a rust preventative and held as reparable bearings in Reparable Warehouse pending further disposition.

SECTION VII

EQUIPMENT

VII. Equipment. (SUGGESTED LIST)

1. Based on processing 3000 bearings per day, it has been estimated that the following equipment will be required:

a. Office Area.

(1) 2 Desks.

(2) 5 Chairs.

(3) 2 File Cabinets.

(4) 1 Table, 2' x 3'.

b. Receiving Area.

(1) 2 Tables, 3' x 8'.

(2) 2 Stools.

(3) 1 Desk.

(4) 1 Chair.

(5) 1 Demagnetizer, 14" throat. (Approx.)

(6) Suitable Storage Shelving.

c. Cleaning Room.

(1) 1 Degreaser. See Figure 1.

(2) 4 Cleaning Vats. These vats should incorporate the principals of agitation, heating and filtration.

(3) Rinsing Vat. (Same as above.)

(4) 3 Wash Stands.

(5) 1 Fixture for washing rocker arms.

(6) Kerosene Vat.

(7) Water Trap & Filtering Unit for Compressed Air.

(8) Rinse Vat - agitation.

(9) Hot Oil Vat.

(10) Hot Grease Vat.

(11) Ball Crank Greasing Unit.

(12) 12 Tin Cans with lids for dirty rags and rubbish. (Approximately 30 gallon size.)

(13) 6 Drill Presses -(Cleaning machines for supercharger bearings.)

(14) 4 Tables, 3' x 4'.

(15) 6 Stools.

(16) Still for Filtering Unit.

(17) Filter for Solvents.

(18) Solvents and Liquids.

(a) Degreasing, Trycol-Ethylene.

(b) Cleaner, Bendix or suitable - Gunk Hydroseal.

(c) Rinse, Kerosene or suitable - Stoddard Solvent.

(d) Before cleaning heavy motor oil.

(e) After cleaning light motor oil.

NOTE: Never use water in the bearing department except when subjecting bearing retainers to Bright Dipping.

d. Visual Inspection Area.

(1) 3 Tables, 10' x 3'.

(2) 10 Stools.

e. Main Inspection Area.

(1) 1 Lateral Gage.

(2) 1 Radial Gage.

(3) 1 Rockwell Tester.

(4) 1 Bore Gage. Set-plug gage - "go & no-go". See Figure 2.

(5) 1 O. D. Gage. Sheffield Gage. See Figure 3.

(6) 10 Magnifying Glasses. (5 Power Lighted)

(7) 10 Feeler Gages.

(8) 2 sets Micrometers.

(9) 2 Microscopes.

(10) 2 Noise Testers.

(11) 10 Scribes.

(12) Sufficient Tables & Stools.

f. Rewrapping Area.

(1) 2 Vats - Hot Oil.

(2) 3 Tables, 3' x 10'.

(3) 1 Vat - L. & R. Rinse (Agitation Principal.)

(4) 1 Vat - Hot Grease.

g. Rework Room for Minor Repair.

(1) 1 Roller Buffer.

(2) 12 Motors with steel and horsehair brushes. (Bench type grinder buffer, 17-A Stock, Stock No. 136000.)

(3) 2 Tables, 3' x 10'.

(4) Sufficient Stools and Benches.

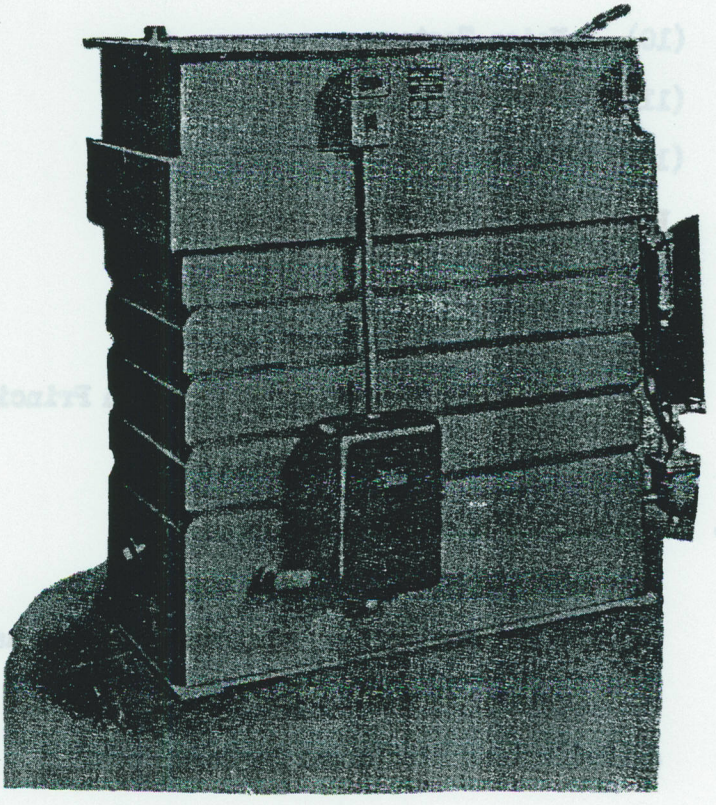
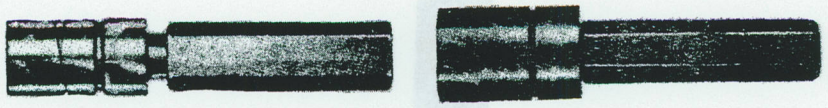


FIGURE 1

Degreaser



Suitable Bore Gages

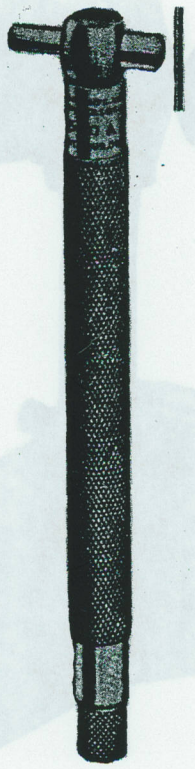


FIGURE 2

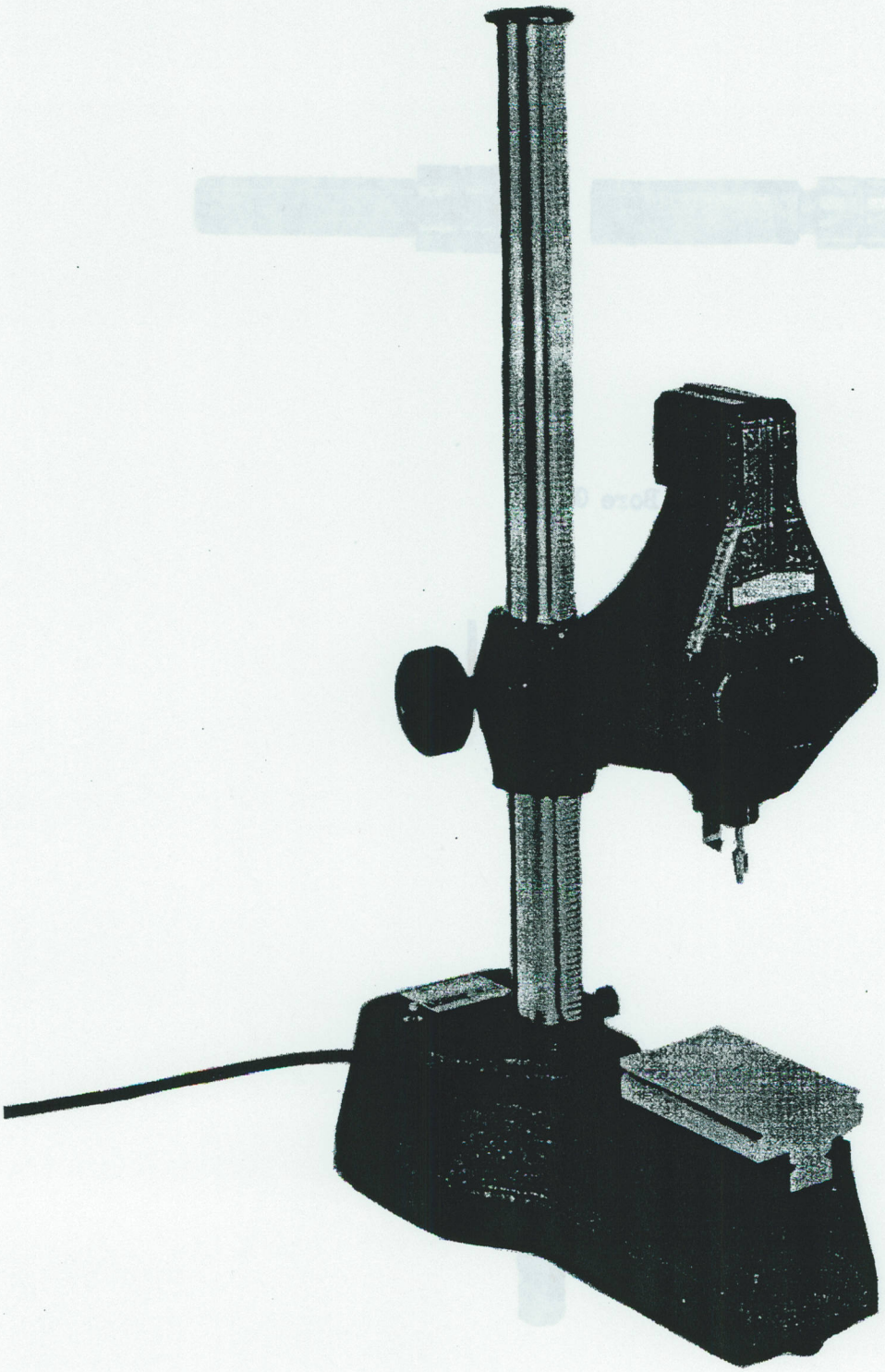


FIGURE 3
Comparator Gage

SECTION VIII

PRODUCTION SHOP FLOW

VIII. Production Shop Flow.

1. It will be essential to process the used bearings in an orderly manner in order to have maximum efficiency with regard to inspection and also to accomplish the processing of the bearings quickly.

2. It is apparent that the accumulated bearings at each Depot should be segregated into individual sizes and types before endeavoring to clear them through the bearing maintenance department.

3. In order to maintain the progressiveness of the bearing maintenance department it is suggested that a form be used similar to that shown in Figure 4. This form is to be used only for reference work within the bearing department.

4. Preparation of Bearings before Entering Bearing Department. When bearings are removed from equipment throughout the Depot, each bearing will be dipped in an oil bath containing grade S.A.E. 30 or S.A.E. 40 oil. This is necessary to prevent rust or corrosion of the bearing intransit to the bearing department and to protect the bearings for a few days in the event that the bearing department cannot process such bearings at once. The bearings will be put into a suitable dirt free container. Bearings should not be permitted to accumulate in the respective departments at the Depot when they have been removed for overhaul, but should be released to the bearing department with the least possible delay. It is also essential to maintain a sequence of operation within the bearing maintenance department in order that the proper treatment may be given to various bearings at the proper time. The following steps give a systematic production flow of a bearing from one end of the shop to the other and from actual experience any interruption in this flow results in an inefficient bearing maintenance:

SUGGESTED LOCAL FORM FOR BEARING MAINTENANCE*

Week Ending:_____
Friday Midnight

NOTE: Group Bearings as nearly as Possible.

	1	2	3	4	5	6	7
Equipment	On Hand Unprocessed	Received	Cleaned	Serviceable	Unserviceable	Hold For Disposition	Serviceable Returned to Local Issue
a. Engine							
b. Magneto							
c. Generator, Starters, Pumps, etc.							
d. Propellers							
e. Super-chargers							
f. Wheels							
g. Misc.							
h. Non Removable Bearings							

FIGURE 4

*This form is to be used by the bearing maintenance department only for purpose of record within the department.

a. Storage and Receiving.

b. Degreasing.

c. Demagnetizing.

d. Cleaning.

e. Rinsing.

f. Kerosene Wash.

g. Drying.

h. Segregation and Visual Inspection.

i. Rework (minor repair)

j. Main Inspection.

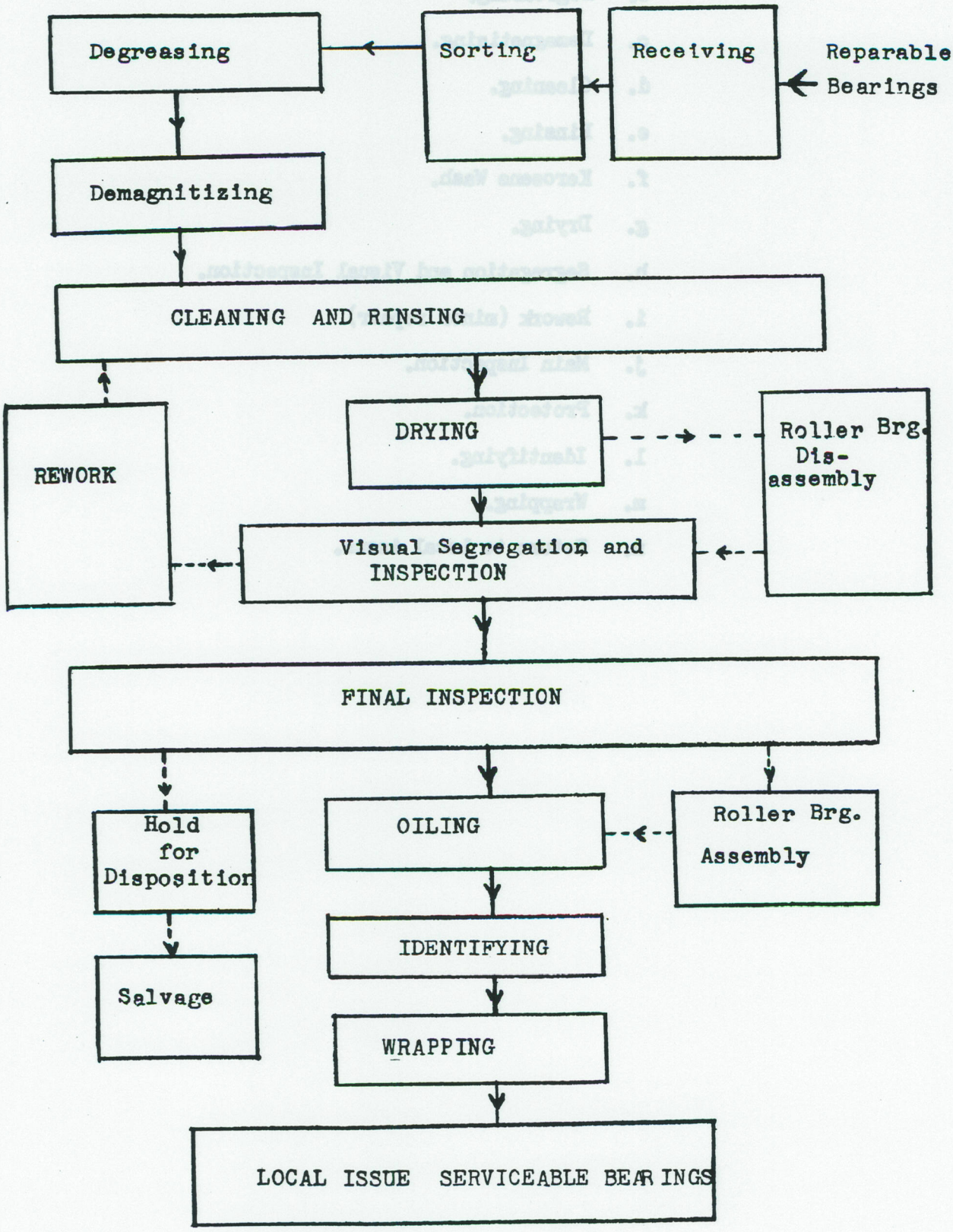
k. Protection.

l. Identifying.

m. Wrapping.

n. Return to local issue.

PROGRESSIVE PROCEDURE FOR BEARING MAINTENANCE



SECTION IX

CLEANING OPERATIONS

NOTE: It is important that all bearings which are being processed by the bearing department be handled with utmost care in order that the component parts of the bearing are not abused.

IX. Cleaning Operations.

1. Degreasing.

a. Operations. Used bearings will first be sent to the degreasing stand where all excessive foreign matter and grease can be removed. The best way to accomplish this operation is by means of a degreasing machine which can be obtained from the commercial market. See Figure 1. Most of these machines incorporate several steps. The first is heating, which opens up the metallic pores of the bearing surface and allows the particles to crack off the surfaces. The second step involved is that of cleaning the bearing by means of agitation in the degreasing solvent which removes most of the loose particles imbedded on the raceway. The third step is in draining and drying the bearings before they go to their next operation. For the most part, anti-friction bearings will be in rather good condition as far as oxidized grease and dirt are concerned after coming through the degreasing machine.

b. Equipment. Commercial degreaser.

c. Personnel. One - low skill.

d. Utilities. Trycol-Ethylene, water, compressed air.

2. Demagnetizing.

a. Operations. All bearings which have been in service are subject to the electrical forces which are established in the rotation of the machinery and therefore, become magnetized. It is necessary to demagnetize these bearings as they come from the degreasing department. Demagnetizers may be purchased from a local commercial source, fabricated by local manufacture or such machines now available at the various Depots may be utilized. The demagnetizers should be set up in the line of production within the bearing maintenance department. Foreign matter

which comes from the various component parts of the engine as well as other pieces of equipment break up during normal operation and due to the magnetic forces set up in the bearing, these particles adhere to the bearing surfaces. Such a condition is very destructive to the highly polished raceways, and, therefore, it is essential that all bearings be demagnetized. In demagnetizing these parts it will be necessary to pass them through the machine at least once in a forward direction and once in a reverse direction and, at the same time, rotate the bearings slightly while in the demagnetizer. This operation will assure a near perfect demagnetization. See Figure 5.

b. Equipment. 1 Demagnetizer -/14" throat, 1 Table - Approx. 3' x 4'.

c. Personnel. One - low skill.

d. Utilities. 220 Volt circuit.

3. Washing.

a. Operations. The bearings are now ready for a more complete cleaning, preferably by a mechanical means which will allow the bearing to be rotated at a speed of 100 r.p.m. or less in a cleaning solvent. See Figures 6 and 7. In the event that a mechanical machine is not available, a series of 4 or 6 vats can be used with a common selector valve and filtration unit. The vats can be used to clean the bearings and then can be filtered for the next batch of bearings. It has been estimated through research that the quality of the solvent does not have as important function in the cleaning of bearings as do the following three principals:

(1) Agitate the cleaning solvent in the various vats either by air pressure or by inserting a propeller

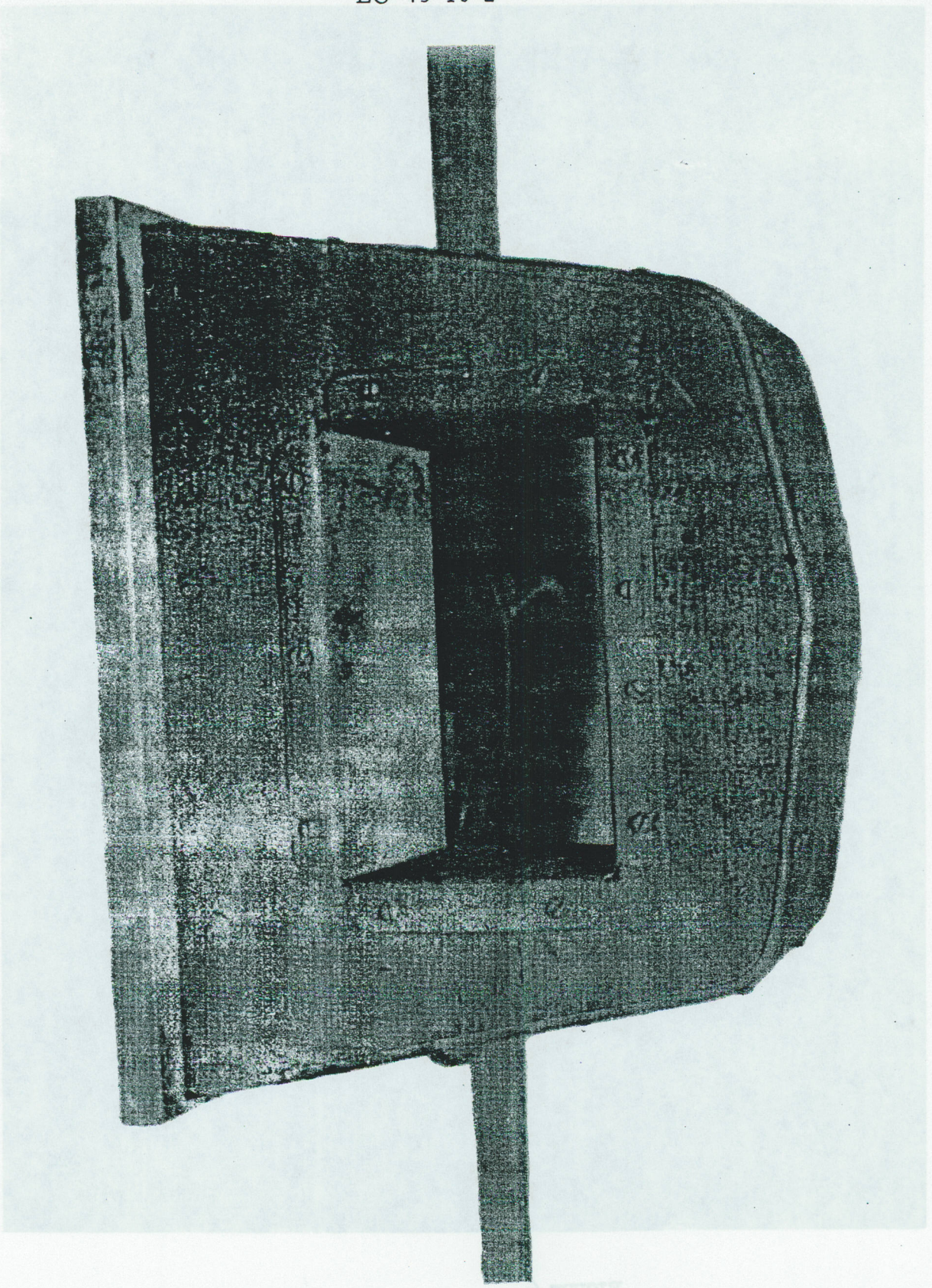


FIGURE 5

Demagnetizer

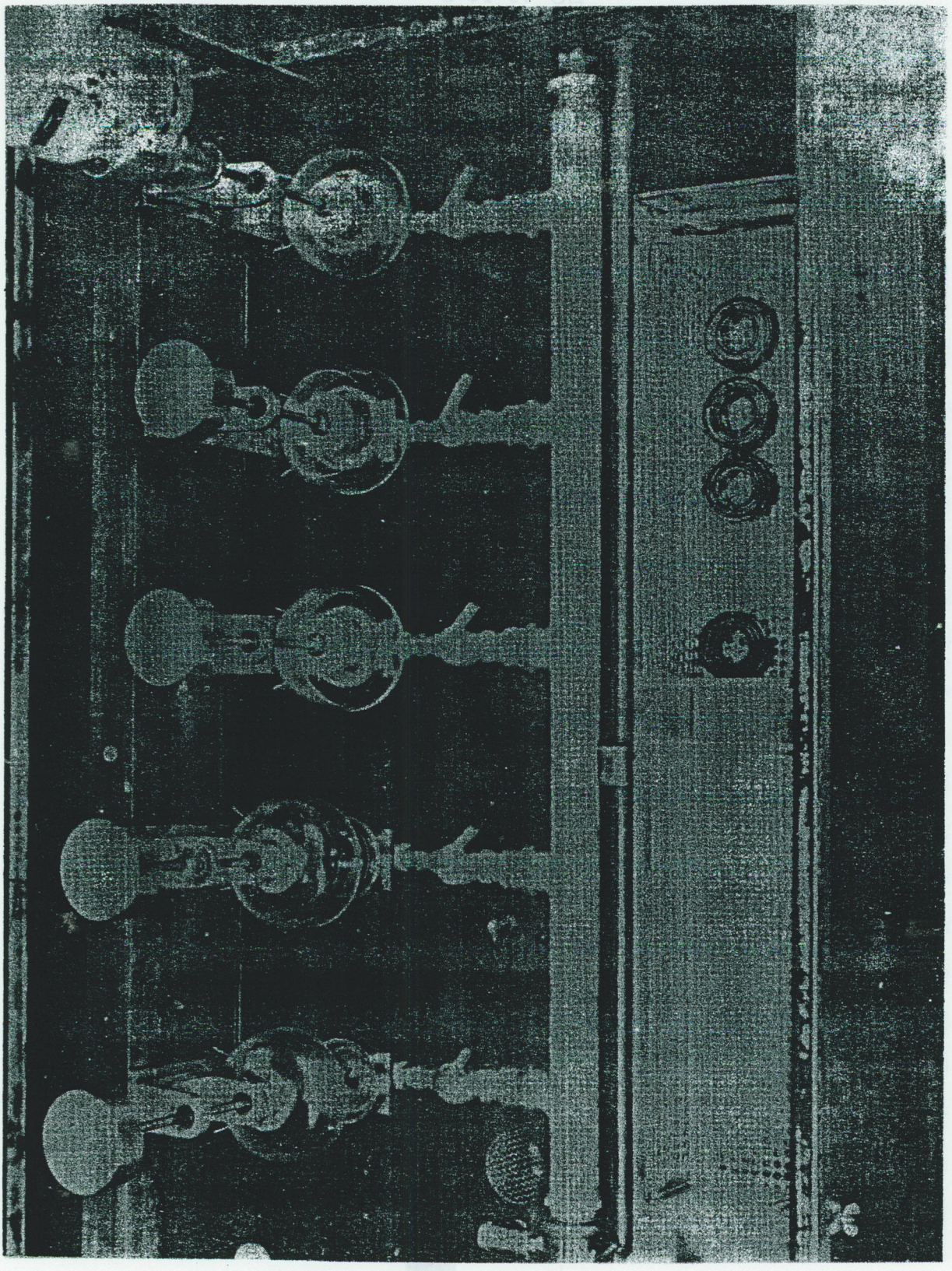


FIGURE 6

Cleaning Machine

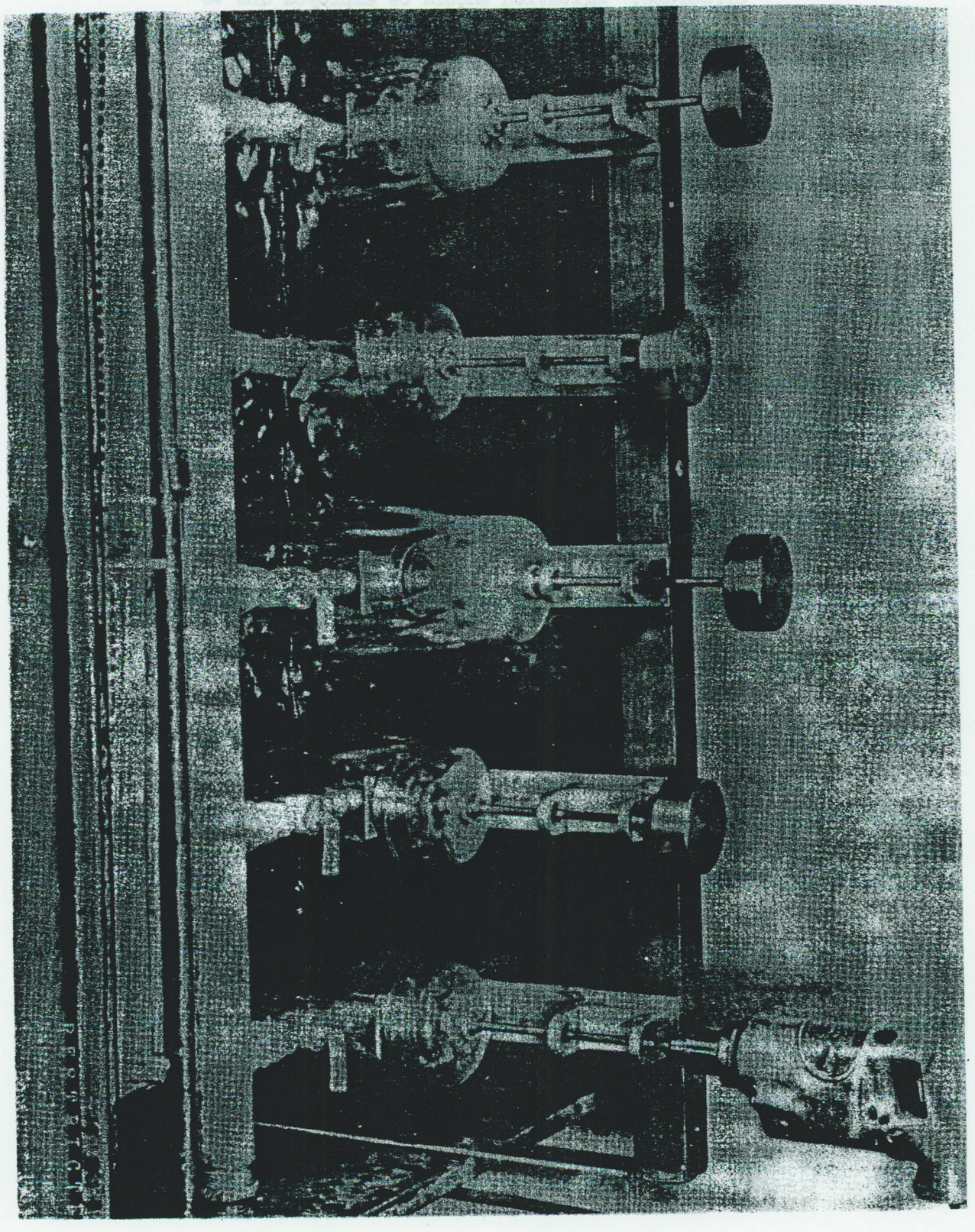


FIGURE 7
Cleaning Machine

type fan into the solvent, causing the liquid to circulate. Agitation should be employed due to the fact that the actual flow of solvent through the bearing will wash loose particles from the bearing. The bearings should be set with the axis horizontal in the cleaning vats so the solvent can circulate through the bearings. Wire baskets can be used for handling bearings. When the baskets are lowered into the solvent, an attempt should be made to keep the baskets from touching the bottom of the vat where it is possible that dirt will settle.

(2) Heating of the solvent to a temperature of 115° F. is required to open up metallic pores of the bearing surfaces. Such a reaction releases the bond between the foreign particles and the steel structure so that following this procedure there is an extremely clean surface. Careful consideration will be given to the flash point of the various solvents when heating due to the fire hazard involved.

(3) The next problem involved is that of filtration, inasmuch as dirt washing out of one bearing will readily wash into another when there is no provision for filtering the solvent. Suitable filtering units should be employed and can be obtained either from available equipment at Depots or from a local commercial source.

b. Equipment. 10 wire baskets; 4 or 6 cleaning vats incorporating agitation, heating and filtration principals; 1 wash stand, 1 fixture rocker arm bearings; Bendix cleaner, Gunk Hydroseal or suitable.

c. Personnel. Three - low skill. One - medium skill.

d. Utilities. Compressed air, floor drain, ventilation for fume evacuation.

4. Rinsing.

a. Operations. It is necessary to rinse all bearings as they come from thepreceding step in order to wash off the remaining particles and also to remove the previously used solvent. See Figure 8. Kerosene may be used for this rinse due to the fact that it leaves a film on the raceway which is favorable in preventing corrosion as the bearing travels through the cleaning and inspection departments. A good grade of kerosene, however, should be used to accomplish this work as low grade kerosene contains properties which react unfavorably to bearing surfaces. Where it is possible to secure Mineral Seal from local source, it is suggested that it be used in preference to kerosene due to its ability to create a favorable film on the surface structure.

b. Equipment. 2 wash stands, 2 spray pressure guns, 2 kerosene vats, 1 drain table.

c. Personnel, Four-low skill.

d. Utilities. Compressed air, drain.

5. Drying.

a. Operations. Before bearings can be actually inspected, they must be dried in order to have a perfect vision of all of the com-

ponent parts of the bearings. This drying should be accomplished by means of compressed air pressure which has been dehydrated and filtered. The bearings should also be dried with a lint free cloth. Such a drying procedure will prevent, to a large degree, the corrosion due to human beings' acidity and atmospheric conditions which may occur. Bearings should not be spun by air.

b. Equipment. Air hose, water trap and filtering units, lint free cloths.

c. Personnel. Four - low skill.

d. Utilities. Compressed air.

6. Inspection.

a. Operations. The bearings are now ready to be processed by the bearing inspection department and the operation involved is outlined in Section XI of this Manual. All cylindrical roller bearings which can be easily disassembled without removing rivets should be disassembled and placed in a box suitable to hold the component parts of the bearing. The various parts of the cylindrical roller bearing can be inspected individually. Care should be exercised not to mix-up the component parts of one bearing with the component parts of another.

b. Equipment. 1 lateral gage, 1 radial gage, 1 Rockwell tester, 1 bore gage, 1 O. D. gage, 10 magnifying glasses, 10 feeler gages, 2 sets micrometers, 2 mocroscopes, 2 noise testers, 10 scribes.

c. Personnel. One - high skill, three - skilled, six - medium skill.

d. Utilities. Lighting fixtures at each bench.

7. Rework.

a. Operation. Many bearings coming through the cleaning room will not pass inspection due to conditions such as rust, etc.

Quite frequently such bearings can be reworked and the process involved in accomplishing this work is outlined in Section X of this Manual under the subject "Rework".

b. Equipment. 1 roller buffer, 12 motors with steel and horsehair brushes. (Bench type grinder buffer, 17-A Stock, Stock No. 136000.) Emery and crocus cloth, cloth buffing wheels.

c. Personnel. Six - medium skill.

d. Utilities. Good lighting, 110 Volt circuit, ventilation for evacuation of foreign matter.

8. Second Rinsing.

a. Operations. After the bearings have been through the bearing inspection department it is necessary to subject them to a rerinsing solution which is highly agitated and through such a reaction the oxidation and corrosion which may be present on the bearing will be removed.

b. Equipment. 2 vats for kerosene.

c. Personnel. Two - low skill.

d. Utilities. Compressed air.

9. Oiling.

CAUTION: After the bearings have been rerinsed, the personnel handling such bearings should be equipped with rubber gloves and the bearings should not be handled by the naked hand until reinstallation.

a. Operations. The bearings are then placed in a vat in which there is a light grade motor oil or melted petrolatum. This oil should be heated and maintained at a temperature of 150° to 180° F. and the bearings should remain in the solution for approximately 10

minutes. Following this procedure will prepare the bearings for storage and will place a film of rust preventive over the raceway and at the same time will not permit the lubricant present to harden forming a resistance to the rotation of the ball or roller bearing. Bearings which are prepared for short time storage can be dipped in light grade motor oil. Short time storage is not to exceed 60 days whereas long time storage will be for over 60 days or for overseas shipment. In the event of long time storage melted petrolatum will be used. Careful consideration will be given with regard to using a mineral base grease and oil so that all oxidation and hardness of the lubricant can be eliminated.

b. Equipment. 1 thermostatic oil vat, 1 thermostatic grease vat, 1 pressure greasing unit.

c. Personnel. Two - low skill.

d. Utilities. 220 Volt electric connections.

10. Identifying. It will be a function of the bearing maintenance department to properly identify all bearings which come through the inspection department in order that the proper bearing nomenclature, code number and classification can be clearly marked on the outside of the bearing package.

11. Wrapping. The bearings are now ready to be wrapped and should be placed in a special oil wrapping paper (ANP-12) Grade A, and then rewrapped in standard wrapping paper or placed in a bearing box especially prepared for this purpose. The latter is preferable. See Figures 9, 10, 11 and 12.

12. Dispatch. All bearings will then be dispatched to local issue established in conjunction with the bearing maintenance department. See Figure 13.

13. Caution: Skin Inflammation

a. Use of certain cleansers in conjunction with bearing washing may react unfavorably to personnel unless certain precautions are taken. The following rules are helpful in maintaining healthy, operating conditions.

(1) Keep clean by washing in hot water with a mild soap (Lan-O-Kleen) several times a day. Lan-O-Klean soap replaces oil which may be removed from the skin by certain cleansing materials.

(2) Wear clean work clothes. Dirty work clothes massage grease, oils, metals, and dirt into the skin and body. At all times wear protective clothing approved by Industrial Hygiene and Safety Departments for a particular job.

(3) Use protective hand cream or skin balm before making contact with cutting oils. Cream which can be used on parts of the body contacting the oils, grease, and dirt is known as Cream-Hand Protective No. 18000C.

(4) Assistance in these problems can be had through the local Industrial Hygiene Department.

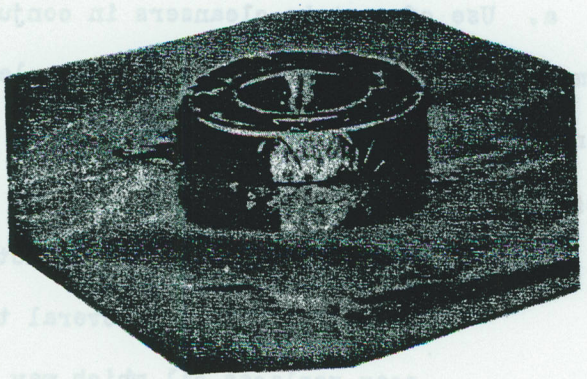


FIGURE 9

Step 1 in Wrapping

FIGURE 10

Do not Break Package

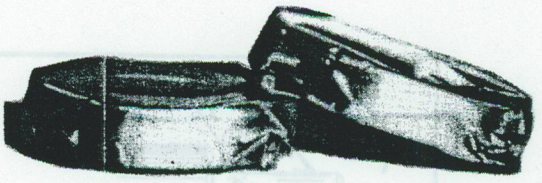


FIGURE 11

Step 2 in Wrapping

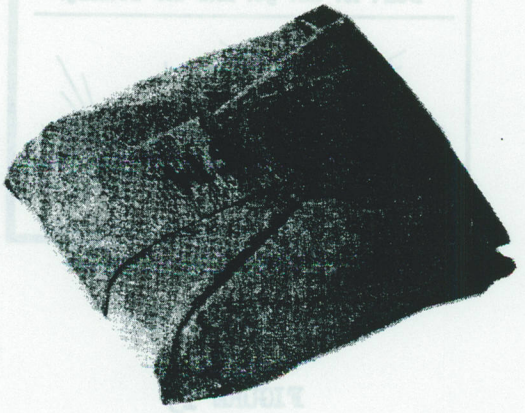


FIGURE 12

Step 3 in Wrapping

If Boxes are Available, Packages Can then be Boxed.

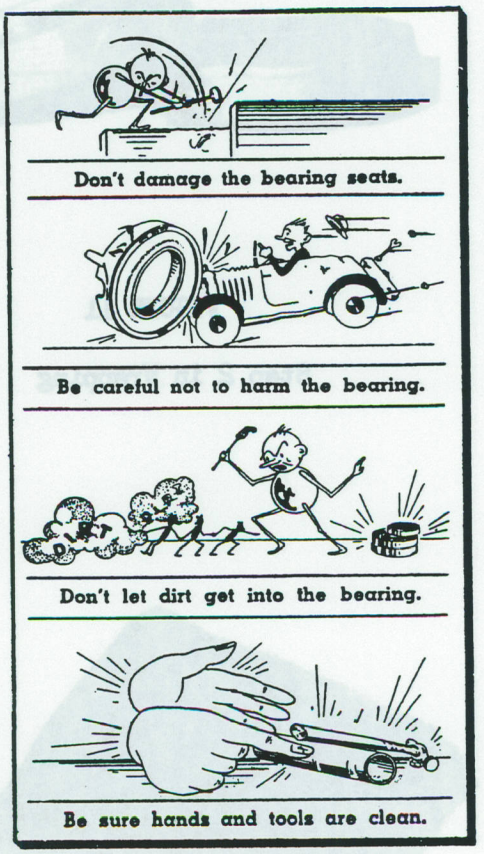

Don't damage the bearing seats.
Be careful not to harm the bearing.
DIRT
Don't let dirt get into the bearing.
Be sure hands and tools are clean.

FIGURE 13

SECTION X

REWORK

X. Rework.

1. Many bearings coming through bearing maintenance department will not pass inspection due to conditions such as rust on the external surfaces, evidences of tarnishing, corroded parts and retainers, galled spacer rings, slightly scarred rollers and raceways, etc. Consequently, the rework room will set up various operations to accomplish the necessary work in order that bearings in conditions similar to those outlined above can be made serviceable. The following procedures can be established to do this work:

a. Retainer Cleaning. Bronze and brass retainers which are subjected to operational conditions in most engines become tarnished and corroded to such an extent that the cleaning operations previously mentioned do not remove corrosion. All such retainers should be removed from the bearings and subjected to "Bright Dipping." This operation should be accomplished in the following four steps:

(1) Dip the retainer into a solution of:

(a) 1 part H_2SO_4.

(b) 1 part HNO_3.

(c) 2 parts H_2O.

(d) 3 ccs. HCL.

(2) Dip the retainer in a cold water rinse.

(3) Dip the retainer in a cold water rinse.

(4) Dip the retainer in the following:

(a) 3 lbs Na_2CrO_7.

(b) 300 ccs. H_2SO_4.

(c) 4 gals. H_2O.

(5) Dip the retainer in a hot water rinse maintained at 180° F.

SECTION X

NOTE: For "Bright Dipping" the correct amount of HCL is 3CC's for 25 gallons of mixture. Any smaller mixture will reduce the HCL proportionally.

Only bronze and brass retainers which have corrosion growth that interfers with the free rotation of the rolling elements need be subjected to this "Bright Dipping."

(6) This reconditioning will prevent the retainer from further corrosion and tarnish and will, at the same time, thoroughly clean all surfaces.

b. Removing Rust. Many bearings coming through inspection will be rejected due to the presence of rust on the bearing surfaces. All bearings which are deeply rusted on the raceways should not be reworked by any equipment in the bearing maintenance department due to the fact that the rust in all probability has deteriorated the race surfaces. Under no circumstances should other forms of corrosion be construed as being rust and for further reference to this matter refer to the subject "Policies in Quality Control." All rust which appears on the external surfaces should be removed by buffing, preferably with a steel wire brush having a wire diameter of .003 inch. Following any buffing procedure it will be essential to again process the bearings through the cleaning department.

c. Buffing. A number of raceways and rollers on cylindrical roller bearings will contain slight scratches due to the presence of foreign material in the bearing during operation. These scratches are not detrimental to the normal operation of the bearing providing the metal is not smeared. Such parts should be buffed, using a light steel wire brush of .003 inch wire diameter and a standard horsehair brush. Such buffing will remove the slight scratches and will polish the raceways making them comparable to new bearings. Jeweler's rouge can be used to assist with this buffing. Even though a light steel wire brush is used it is possible to burn slightly the raceways of bearings by placing too much tension on the bearing surface. Care should be exercised in order that no raceways be burned. It will not

SECTION X

NOTE: Where it is necessary to buff the external surfaces or raceways of bearings, approved methods are as follows:

(1) Where parts to be buffed can be rotated.--In buffing it is advisable to rotate the member to be buffed. Use of this procedure will preclude the possibility of creating any flat spots on the bearing surface or raceway. Flat spots on any bearing surfact are detrimental to efficient bearing operation, and when flat spots are created on external surfaces, difficulty may be encountered during installation of the bearing.

(a) A mixture of paraffin and lavigated alumina (dry) heated so that the levigated alumina becomes homogenuous in the paraffin can be prepared. Several pieces of broadcloth can then be dipped into the mixture and when soaked removed for drying. By applying this treated broadcloth to the bearing surface to be buffed, a smooth, unscratched surface can be obtained.

(2) When the part to be buffed cannot be rotated.--When this condition is encountered, a cloth buffing wheel can be dipped into the solution as explained in preceding paragraph. The buffing wheel when dry can be mounted on a motor and the parts to be buffed can be subjected to the rotating wheel. Care should be exercised to buff in the direction of curvature in order to prevent flat spots from occurring.

(3) A fine abrasive grit of 500 to 600 mesh can also be sub-

stituted for levigated alumina.

(4) Careful manipulation of such impregnated buffing wheels will produce the desired surface.

(5) Bearings having been subjected to buffing should be sent to the cleaning room for recleaning.

be necessary to buff every bearing. As a matter of fact, very few bearings will be buffed and then only at the discretion of the inspectors. Such bearings will be reprocessed through the cleaning room.

d. Galling. Quite frequently ball and roller bearings will show presence of galling on the external surfaces due to their rotation in the housing. This galling may appear on the lateral faces, O. D. and bore of the bearing. Providing the external physical dimensions of the bearing are held within drawing clearances such galling should be removed by buffing or by use of emery cloth.

e. Roller Buffing. A roller buffing machine should be constructed in order that the rollers in the cylindrical roller bearings needing buffing can be buffed mechanically and quickly.

f. Cleaning. Quite frequently bearings will of necessity be sent to the rework room for further cleaning even though they have been processed in the cleaning department. This is particularly true of supercharger bearings and other high speed ball and roller bearings which are special or critically dirty. Personnel can be utilized to hand clean these bearings by means of hand working the bearings in a special solvent. It is also suggested that necessary machines be devised to accomplish some of this special cleaning mechanically. It is possible to manufacture a simple mandrel upon which can be mounted a number of bearings. This mandrel can then be set in a chuck of a drill press. The mandrel can then be rotated in a vat of hot oil until the bearings become clean. Other similar devices can be used to perform the additional cleaning required.

g. During the visual inspection of the bearings, it will be possible to segregate the various bearings in accordance with the

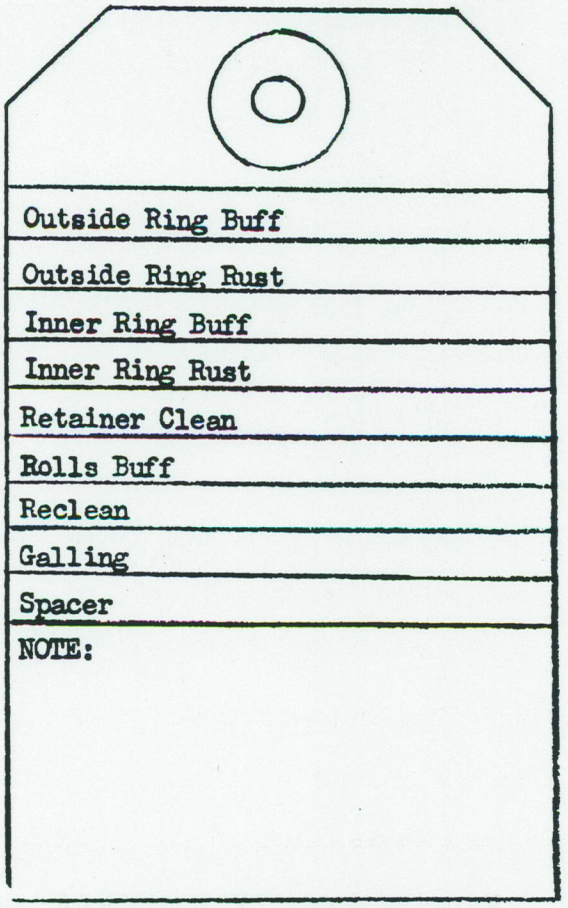
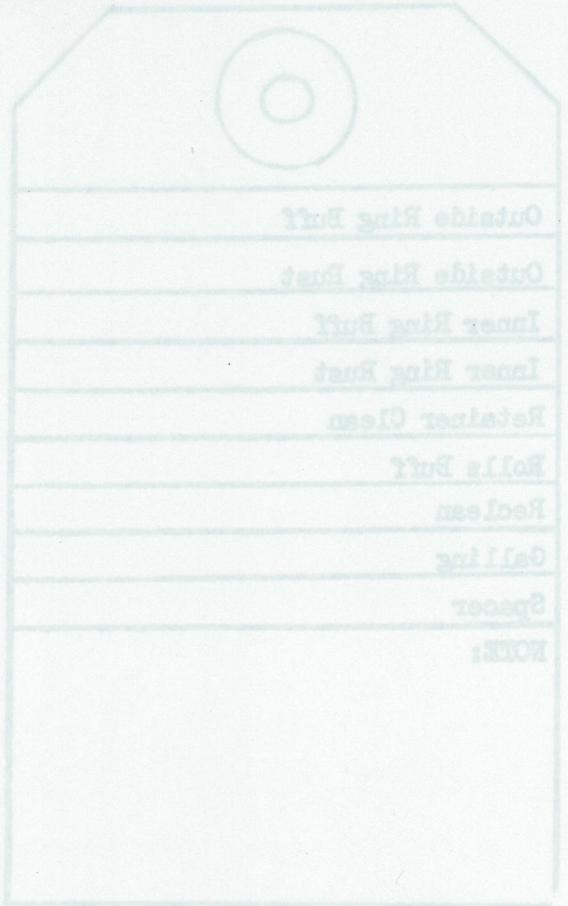


FIGURE 14

Similar Information Can be Written on the Reverse Side of Repairable Parts Tag No. 50 (Green) and will Accompany Bearing in Rework Room.

type of work necessary to make them serviceable by reworking. In this connection, it is recommended that a repairable rework tag be printed at the Depots in order to definitely show the reworkers what work is necessary. A suggested rework tag is shown in Figure 14. The information as shown on Figure 14 can be inserted on one side of repairable parts tag No. 50 (Green)



SECTION XI

INSPECTION

XI. Inspection.

1. This is one of the most important functions in the bearing maintenance department due to the fact that the inspectors will determine all existing irregularities or deficiencies. In this connection two distinct departments consisting of personnel from the inspection department should be established. The first set of inspectors should be stationed so that their inspection can be made as the bearings come from the cleaning room. At this point it will be possible to either pass the bearings as a serviceable item, send the bearing to the rework room for reconditioning, or to reject the bearing. The second set of inspectors should be located at the end of the processing line in order to reinspect all bearings which have been processed through the various steps. The following are progressive steps in making the inspection:

a. Visual Inspection. During this inspection, the bearings can be classified in one of the following divisions: serviceable, reworkable, apparently reconditionable or rejectable. For the time being, the bearing maintenance departments will confine their work to serviceable and reworkable classification. Refer to Figure 15 and 16. All serviceable bearings will be those bearings which can be put back into service after proper cleaning and inspection. All reworkable bearings will be those which can be put back into operation after cleaning and inspection processes and a small amount of work required to remove some minor defects from the bearings. In the visual inspection department, personnel will be acquainted with the policies established by the Air Service Command and covered in this manual under the subject "Policies in Qaulity Control." Personnel will know by sight whether the bearing

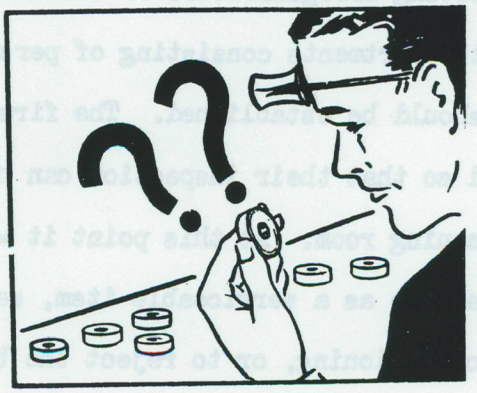


FIGURE 15

Is this Bearing Serviceable?

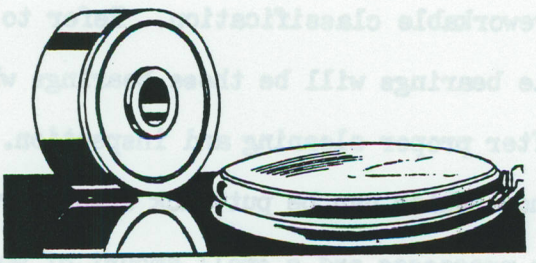


FIGURE 16

A Bearing is as fine as a Watch

is serviceable or whether it is necessary to subject it to further mechanical inspection operations.

(1) The subject of actually regrinding ball and roller bearings is one that would involve a much larger scope than is anticipated for all bearing maintenance departments at the Depots. All bearings which cannot be made serviceable within the scope of these instructions at the respective Depots will be held pending further instructions from this Headquarters.

b. Bore Inspection. Oversize bore bearings - reject or reclaim. See Figure 17 and 18.

(1) The term oversize bore refers to all ball and roller bearings whose inner rings indicate that the bearing has turned on the shaft allowing the rings to wear to such an extent that the physical dimensions are beyond the allowable tolerances. Such bearings will be checked by means of a set of bore gages, most of which are standard at the present time. The bore gages can be either of the no-go type or dial indicator type or plug gage type.

(2) All bearings that have an oversize bore will be held for possible repair by a plating procedure, instructions for which will be furnished at a later date by this Headquarters.

c. O.D. Inspection. Undersize bearings - reject or reclaim. See Figure 19.

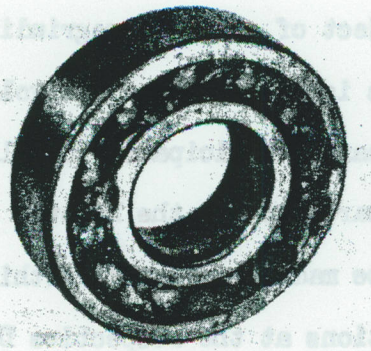


FIGURE 17

Worn Bore Diameter

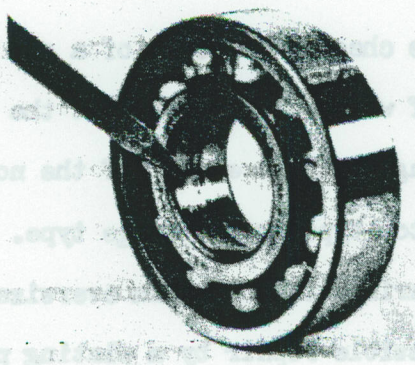


FIGURE 18

Worn Bore Diameter

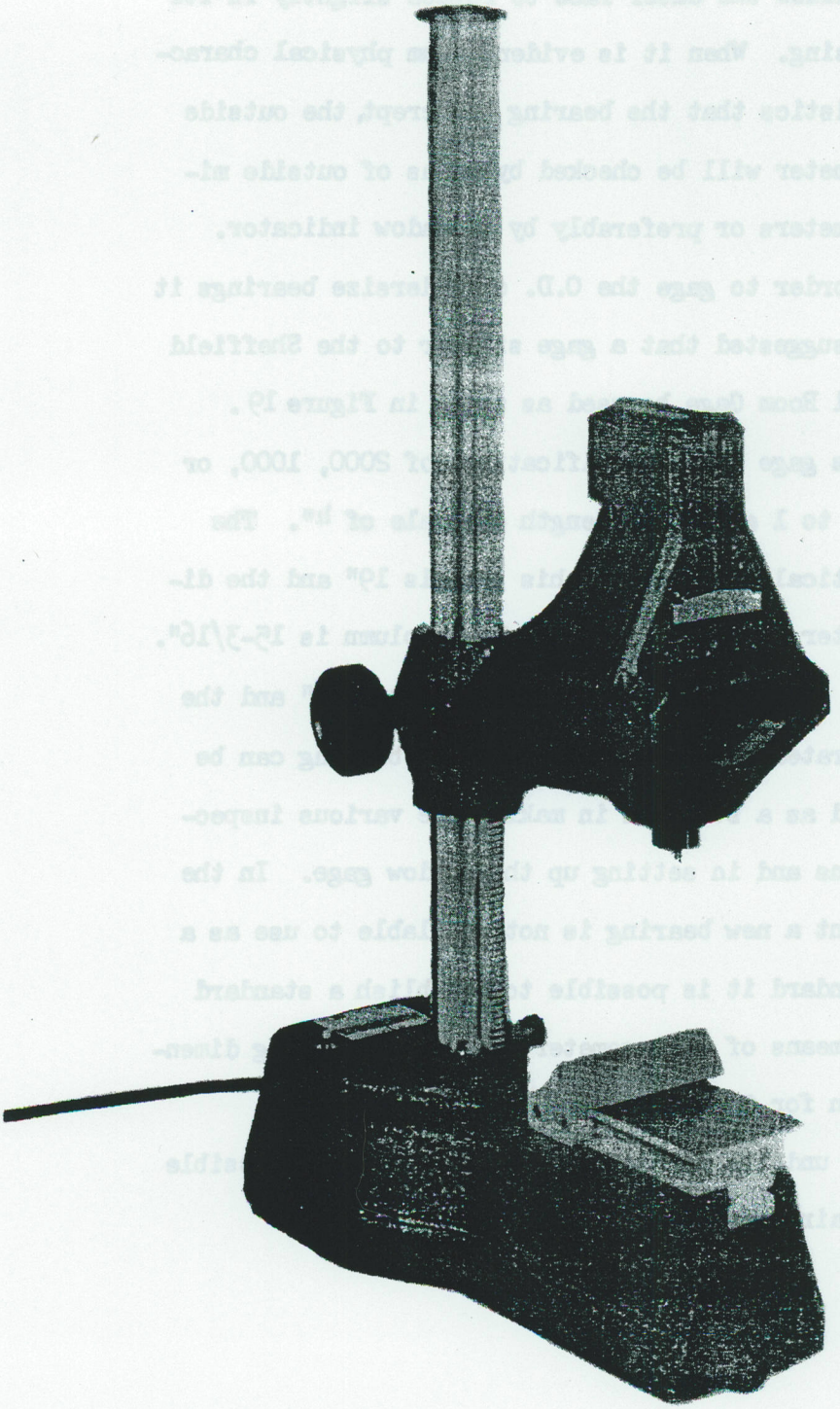


FIGURE 19
O. D. Gage

(1) Quite frequently bearings wear on the outside diameter due to creeping. This is generally due to the fact that bearing diameters either allow for a floating member on the bearing's outer race or allow the outer race to rotate slightly in its housing. When it is evident from physical characteristics that the bearing has crept, the outside diameter will be checked by means of outside micrometers or preferably by a shadow indicator.

(2) In order to gage the O.D. of undersize bearings it is suggested that a gage similar to the Sheffield Tool Room Gage be used as shown in Figure 19. This gage is in magnifications of 2000, 1000, or 500 to 1 and has a length of scale of 4". The vertical capacity of this gage is 19" and the diameter of working circle about column is 15-3/16". The throat, column to gaging point is 6" and the serrated anvil is 3 x 5". A new bearing can be used as a standard in making the various inspections and in setting up the shadow gage. In the event a new bearing is not available to use as a standard it is possible to establish a standard by means of a micrometer gaging and drawing dimension for the particular bearing.

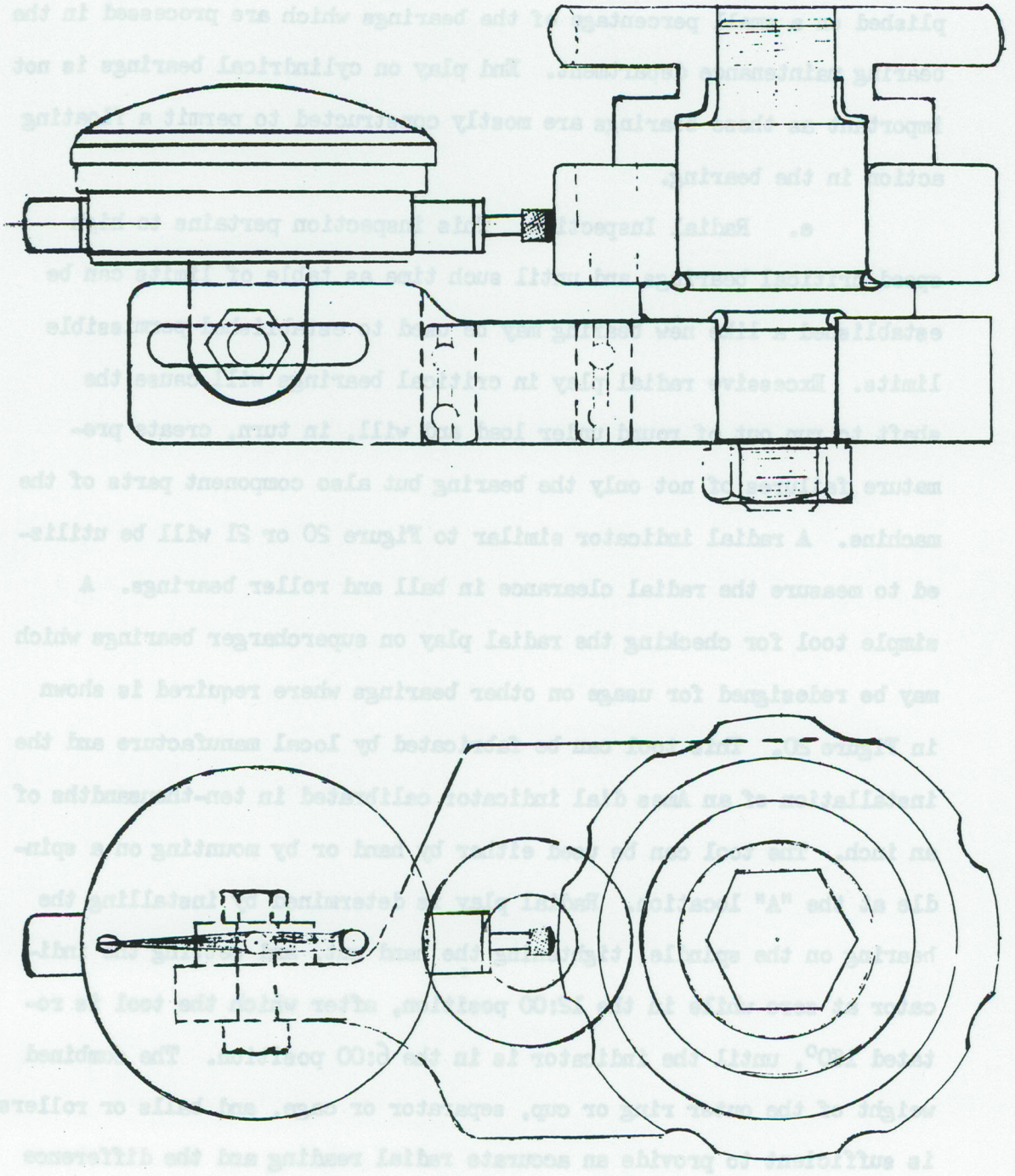
(3) All under size bearings will be held for possible repair by plating.

Lateral Inspection.

d./ Generally speaking this inspection will only be accomplished on a small percentage of the bearings which are processed in the bearing maintenance department. End play on cylindrical bearings is not important as these bearings are mostly constructed to permit a floating action in the bearing.

e. Radial Inspection. This inspection pertains to high speed critical bearings and until such time as table of limits can be established a like new bearing may be used to established permissible limits. Excessive radial play in critical bearings will cause the shaft to run out of round under load and will, in turn, create premature failures of not only the bearing but also component parts of the machine. A radial indicator similar to Figure 20 or 21 will be utilized to measure the radial clearance in ball and roller bearings. A simple tool for checking the radial play on supercharger bearings which may be redesigned for usage on other bearings where required is shown in Figure 20. This tool can be fabricated by local manufacture and the installation of an Ames dial indicator calibrated in ten-thousandths of an inch. The tool can be used either by hand or by mounting on a spindle at the "A" location. Radial play is determined by installing the bearing on the spindle, tightening the hand nut, and setting the indicator at zero while in the 12:00 position, after which the tool is rotated 180°, until the indicator is in the 6:00 position. The combined weight of the outer ring or cup, separator or cage, and balls or rollers, is sufficient to provide an accurate radial reading and the difference in indicator reading between the 12:00 position and the 6:00 position is the radial play in the bearing.

ENGINEERING DEPARTMENT



RADIAL PLAY GAUGE

FIGURE 20
Radial Gage

FIXTURE FOR CHECKING RADIAL PLAY
ROLLER OR BALL BEARINGS

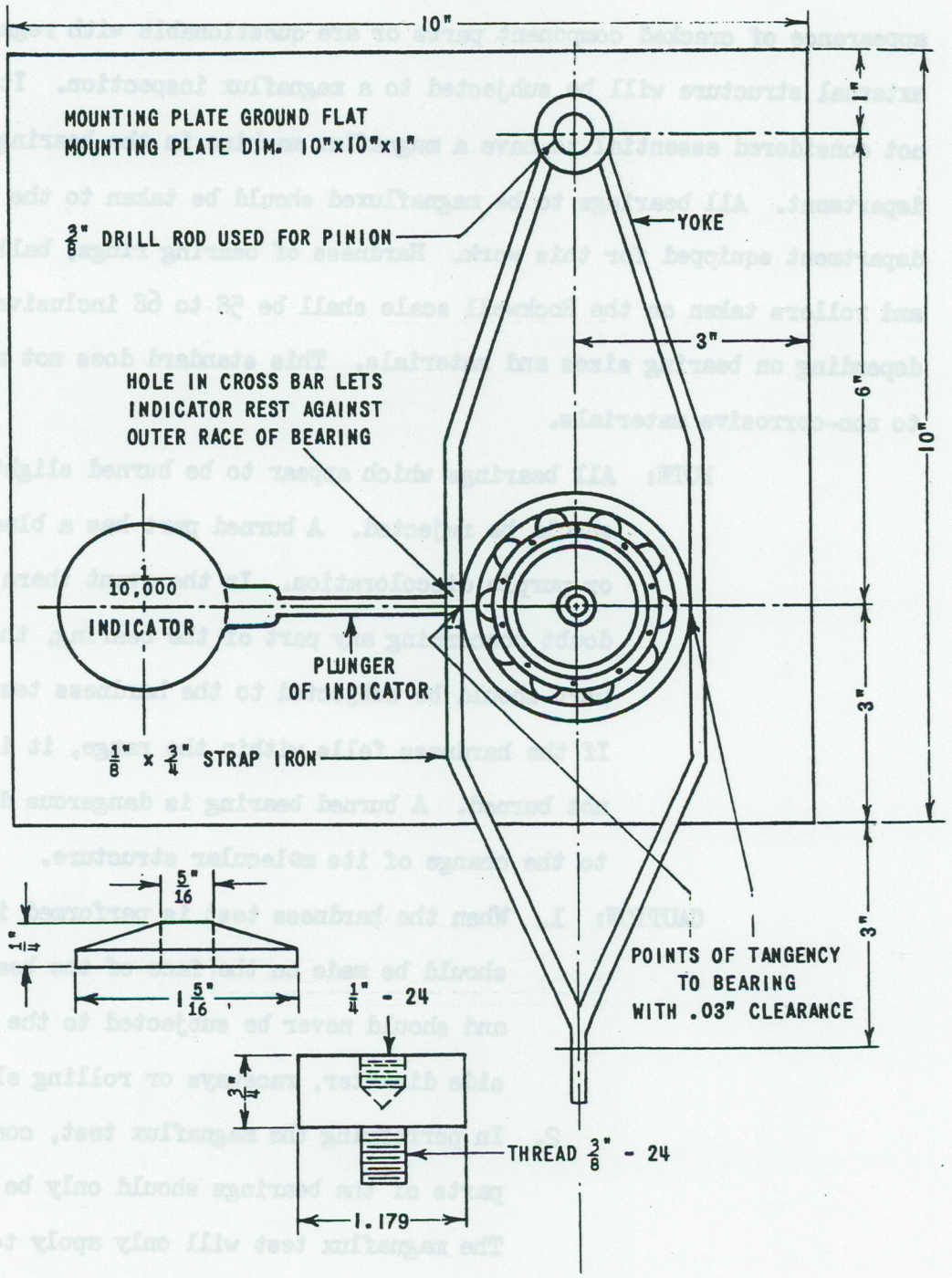


FIGURE 21

NOTE: This inspection should be made with the bearing perfectly clean and dry and without lubrication.

f. Magnaflux and Hardness Test. All bearings which have an appearance of cracked component parts or are questionable with regard to external structure will be subjected to a magnaflux inspection. It is not considered essential to have a magnaflux machine in the bearing department. All bearings to be magnafluxed should be taken to the department equipped for this work. Hardness of bearing rings, balls and rollers taken on the Rockwell scale shall be 58 to 68 inclusive depending on bearing sizes and materials. This standard does not apply to non-corrosive materials.

NOTE: All bearings which appear to be burned slightly should be rejected. A burned part has a blue or purple discoloration. In the event there is doubt concerning any part of the bearing, the part should be subjected to the hardness tester. If the hardness falls within the range, it is not burned. A burned bearing is dangerous due to the change of its molecular structure.

CAUTION: 1. When the hardness test is performed it should be made on the face of the bearing and should never be subjected to the outside diameter, raceways or rolling elements.

2. In performing the magnaflux test, component parts of the bearings should only be used. The magnaflux test will only apply to bearings which can be separated into component

parts. All bearings which have been magnafluxed should be reprocessed in the cleaning department.

g. Noise Inspection. Noise Inspection will detect rough or pitted raceways, flat balls, broken component parts of the bearings, dirt and other imperfections present. This test can be accomplished by either hand rotation or motor driven rotation. If the bearings are rotated by hand no lubrication is required to perform this test. However, if the bearings are rotated by motor, they should be prelubricated with oil and rotated at a speed comparable to the r.p.m. to which the bearings are subjected in their operating mechanism. Noisy bearings should be rejected if the source of noise cannot be removed by recleaning the bearing.

h. After the bearings have been processed through the above inspection, the bearings should be of such a caliber that they are serviceable. When this inspection is accomplished by trained personnel, utmost confidence can be had in assuring the maintenance department that the bearings are ready for service.

SECTION XI

i. Spin Test:

(1) Every bearing should be subject to the "Spin Test". This should be accomplished by spinning the bearing by hand rotation. All ball bearings should be held on their side during rotation and then turned over so that both lateral parts of the raceways come in contact with the rolling elements. The bearings should then be rotated in their normal plane of operation.

(2) Roller bearings can be rotated only in their normal plane of operation.

(3) Such a test should be accomplished while the bearing is being inspected.

SECTION XII

POLICIES IN QUALITY CONTROL

XII. Policies in Quality Control.

1. The appearance and finish of a new anti-friction bearing is in sharp contrast with its usual appearance when it is removed in service overhaul. See Figure 22. In order for inspectors in bearing maintenance department to judge the desirability of replacement it is necessary to know what are significant indications of bearing deterioration for rejection and in addition what features can be ignored as unimportant in effect on operation performance. Certain operating characteristics apply in general to all types of ball and roller bearings and a knowledge of these conditions is basic in order to establish a correct procedure in bearing maintenance for inspection. It is desired that quality control be maintained at all times with regard to anti-friction ball and roller bearings and the following characteristics will enable an inspector to determine the nature of a bearing's serviceability:

a. Flaking - reject. See Figures 23, 24, 25 and 26. Progressive fatigue is the normal form of deterioration and this ultimately becomes apparent as a failure due to flaking or spalling of the load carrying surfaces. Any evidence of flaking on the raceway or rolling elements is cause for rejection as the condition becomes progressively worse at an accelerated rate. Flaking represents an actual breakdown of surface structure and is primarily due to excessive overload. This type of failure presents a typical eroded appearance and in the early stages is usually localized on the inner raceways. When encountered at short service life, it is usually an indication of severe overload conditions.

b. Wear. See Figures 27 and 28. Wear and development of excessive internal looseness within the bearing is the result of abusive

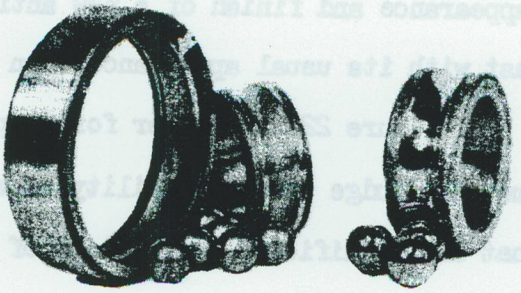


FIGURE 22

A Used Raceway and a New Raceway

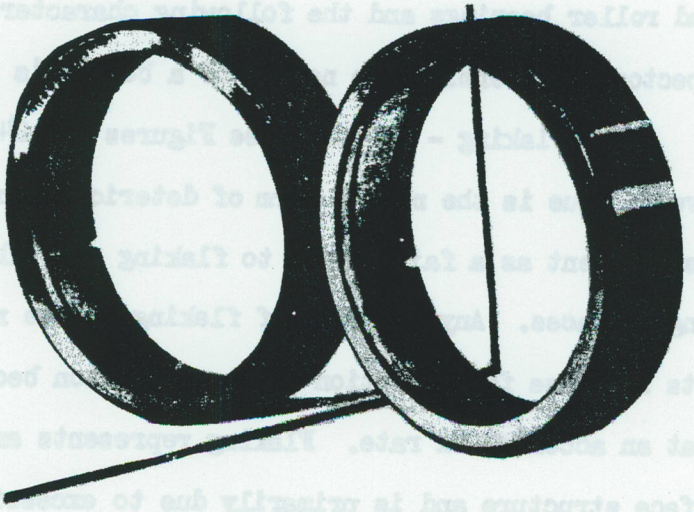


FIGURE 23

Patches of flaking on opposite parts of bearing ring. Cause: distortion of the ring by the housing.

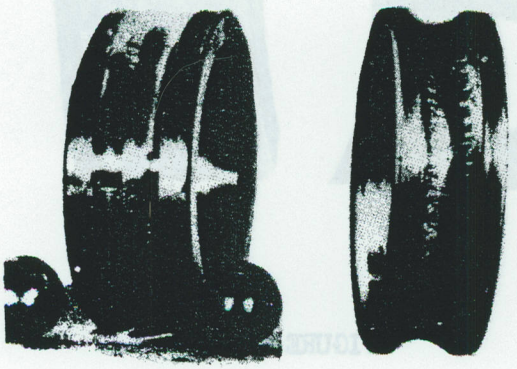


FIGURE 24

Far Advanced Flaking

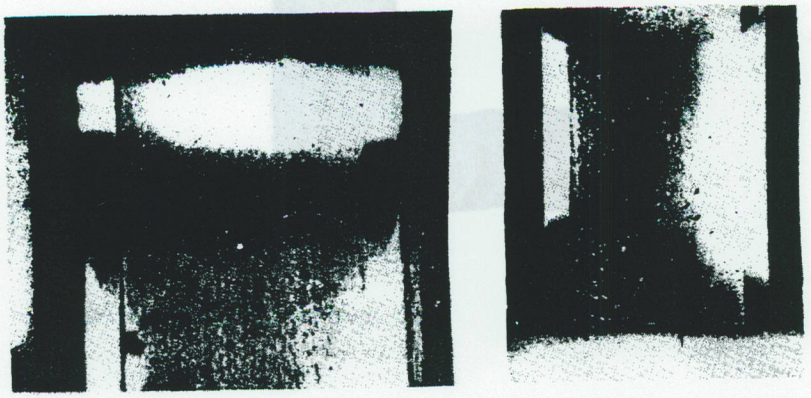


FIGURE 25

Flaking Caused by Edge-Loading

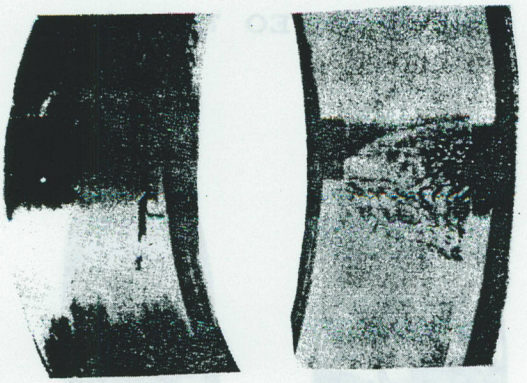


FIGURE 26

Flaking Caused by Surface Fatigue

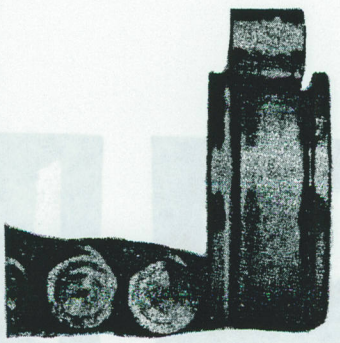


FIGURE 27

Wear Due to the Lack of Lubricant

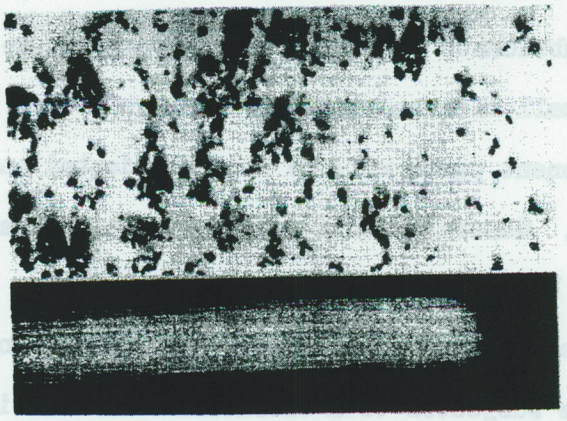


FIGURE 28

Wear Due to Dirt

action. This is generally due to contamination of the lubricant and is aggravated by a corrosion when moisture and acid fumes are present. Under proper operating conditions ball and roller bearings do not develop a perceptible amount of wear throughout their life and unless bearings are subjected to critical high speed conditions, lateral or end play is not cause for rejection unless in an excessive degree.

c. Roughness. Reject or reclean. See Figures 29, 30, 31 and 32. Roughness and a tendency to catch are usually caused by the presence of foreign matter in the bearing and particularly in the retainer adjacent to the ball or roller contact. Dirt, metallic particles and residue of lubricants will have this effect due to etching action in the relatively small clearance in the bearings. When such material is present the component parts will be slightly dented and present a rough appearance. Generally this roughness does not affect future operation of the bearing providing the foreign matter has been removed.

d. False brinelling. See Figure 33. Brinelling results when a bearing is subjected to a vibration while the inner and outer races are in a static condition with respect to each other. The raceways appear to have a sustained heavy load indentation, but actually the condition is due to contact erosion and is localized abrasive wear. Bearings so affected are extremely rough and have a characteristic "rachet feel" when rotated. This condition is cause for rejection.

e. Impact brinelling. Bearings which are subjected to heavy impact loads will permit the ball to dent the raceway similar to the action created by the indentation of ball on a test block in a hardness tester. Such action will distort the molecular structure and cause the bearing to be rough, hence setting up vibration and premature failure. This condition is cause for rejection.

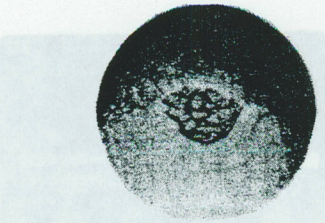


FIGURE 29
Roughness Due to Bad Ball

FIGURE 30

Roughness Due Bad Retainer

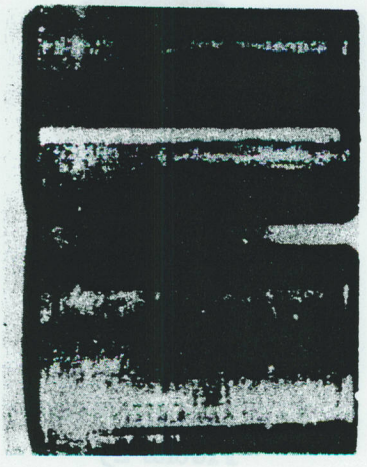


FIGURE 31

Roughness Due to Bad Rollers

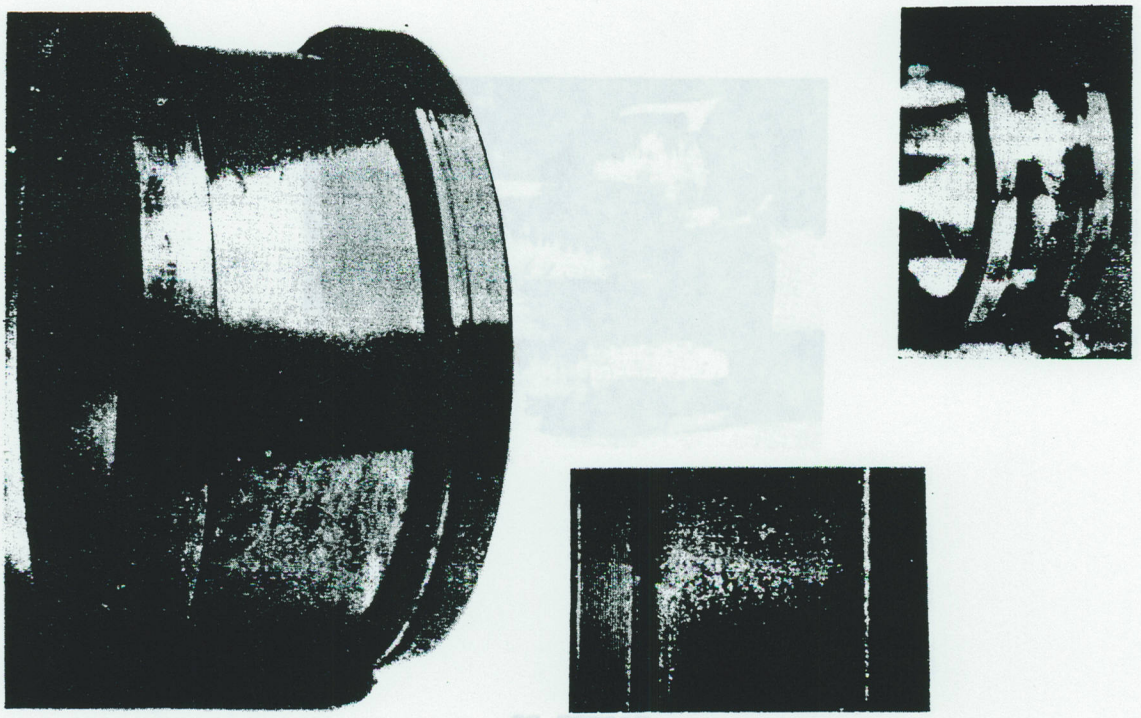


FIGURE 32

Roughness Due to Bad Raceways

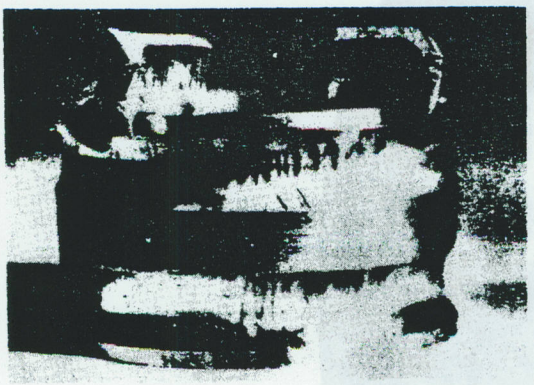


FIGURE 33

False Brinelling

f. Scarring and scuffing. See Figure 34. Scarring and scuffing of external surfaces is due to a creeping action under load and also involves the mating surfaces in contact with the bearings. Surfaces of the bearings so affected should be cleaned up and smoothed before reassembly and should also be subjected to the bore or O. D. inspection tests.

g. Tarnished surfaces. Tarnish is essentially a discoloration of the high finish of the bearing and is generally due to a mild acid condition of the lubricant or the presence of moisture insufficient in amount to cause actual rusting. Bearings showing this condition are serviceable.

h. Pit corrosion. See Figure 35. Pit corrosion is a result of acid fumes or free moisture and may attack all exposed surfaces of the bearing. The principal hazard from this source is the occurence of localized pit erosion in the raceways and on the rolling elements which may serve as focal points for the development of fatigue flaking mentioned in paragraph 1, a, this Section. Close grouping of deep pits is cause for rejection and when localized is more serious in case of ball bearings than roller bearings. It is permissible to pass a cylindrical roller bearing when the pits are not localized and the occurences of same is not frequent. The diameter of such pits should not exceed .005 inch.

i. Rust. Externally - rework. See Figures 36 and 37. Rusting, especially that due to exposure in humid atmospheric conditions, usually results in deep sharp pitting and discoloration and is cause for rejection when it appears on the raceway or rolling elements. The same condition on external surfaces can be corrected by buffing or polishing. Light rust conditions occuring from finger prints or similar conditions

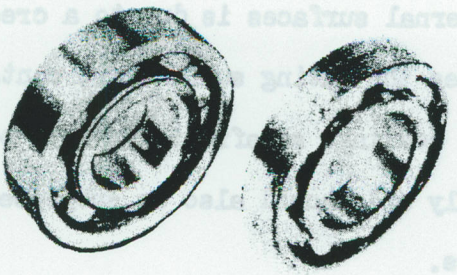


FIGURE 34

A new Bearing and a Scarred

Outer Race Bearing

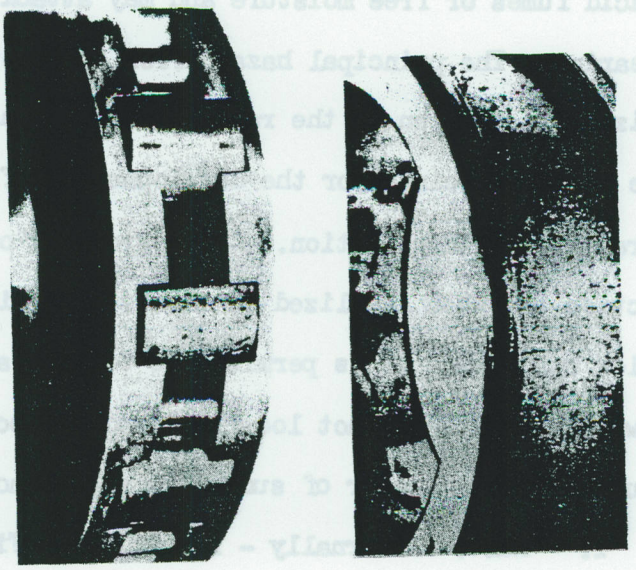


FIGURE 35

Pit Corrosion Due to Acid Fumes and

Free Moisture

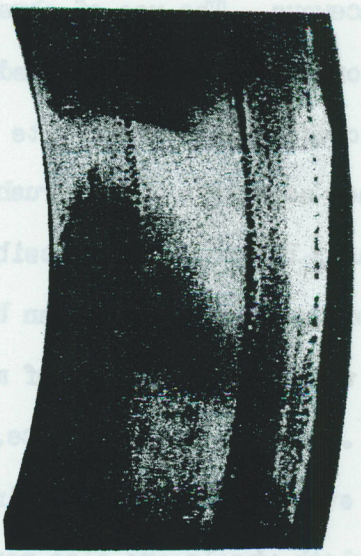


FIGURE 36

Pits Due to Rust

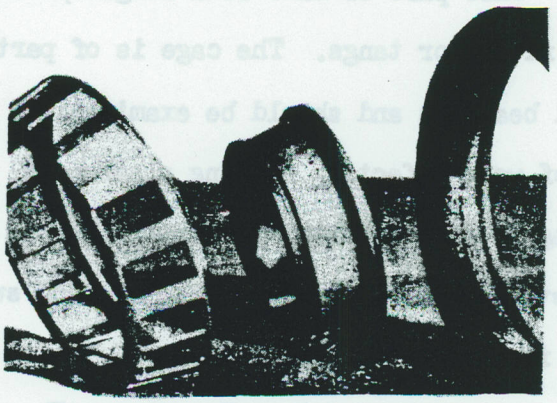


FIGURE 37

Rust and the Wear it Causes

of short duration can be removed by buffing providing extreme care is taken to maintain concentric raceways. The use of abrasives for removing corrosion or rust spots on the races is outlined below:

(1) The use of crocus cloth or Aloxite cloth of 280 grit or finer as well as wire brushing and buffing with horsehair brushes is permissible to remove corrosion or rust spots if it can be readily accomplished without the removal of more than a maximum of .001 inch from the race. Other abrasive materials, such as lavigated alumina, with polishing sticks or cloth wheels are also permissible. Particular care must be taken not to remove more material from the races than is actually necessary. These polishing operations should extend all around the races and not be limited to spotting.

j. Cage wear. See Figure 31. The cage or retainer serving to space the balls or rollers is either of the land centered type or ball centered type. This part is made as a single piece or two pieces held together with rivets or tangs. The cage is of particular importance in high speed bearings and should be examined for structural soundness and evenness of wear affecting running clearances. Metallic cages may develop smearing in the contacts with the balls. A condition like this will be made evident by roughness of the running surfaces. This condition is cause for rejection.

k. Double Plate Sealed Type Bearings. These bearings are subject to deterioration of lubricant as a result of leakage and oxidation. This type of bearing can be no better than the condition of its

lubricant nor can it be inspected thoroughly without removing one of the seals. Experimental work in this connection is being accomplished and further details are forthcoming. For the present procedure in cleaning, self-sealing bearings should be subjected to a hot oil flushing while being rotated at a speed not exceeding 100 r.p.m. followed by pressure lubrication. Proper lubricant can be then inserted in the bearing through the seals by means of a jig (See Figure 38 and 39) which can be easily set up to hold the bearing during its lubricating period. Pressure lubrication should be equipped with sufficient adapters to insure that the grease is channeled as metered to the bearing at a point where the plate seals have an opening into the bearing. This is very important as grease under pressure against the seals will force the seals inward against the retainer thereby causing a locked condition to exist. When the bearings have been pressure lubricated, they should be placed on a rotating cone in order to remove excessive grease. The speed can be comparable to that to which the bearing is subjected under normal operating conditions.

2. Coast and Spin Test on Ball and Roller Bearings. See Figure 40. In view of the lack of mechanical means to check the efficiency of a ball and roller bearing at the present time it will be necessary to check bearings by the spin or coast test. This should be accomplished by spinning the bearing by hand rotation first. All ball bearings should be held on their side during rotation and then turned over so that the lateral parts of the raceways come in contact with the ball curvatures. The bearings should then be rotated in their normal plane of operation. No attempt should ever be made to spin bearings at high speed unless

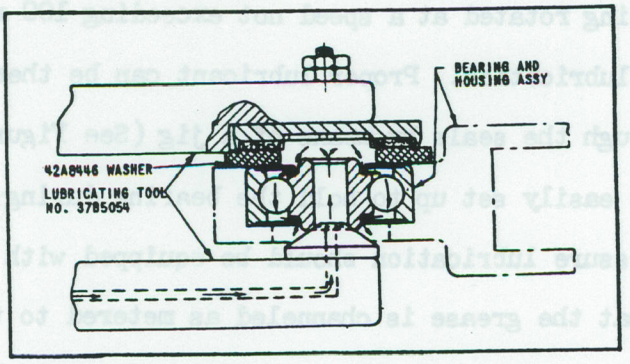


FIGURE 38

Fixture for Greasing Bearing

Part No. 37B-5054

SUGGESTED LUBRICATING JIG FOR SHIELDED BEARINGS

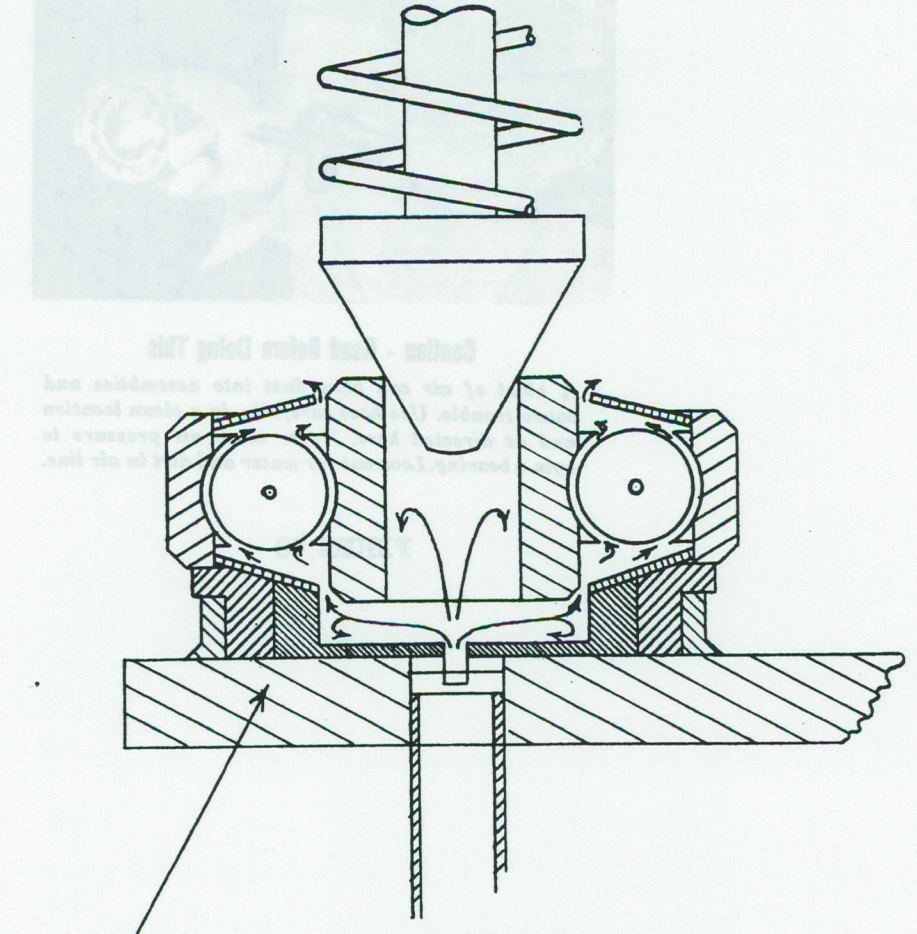
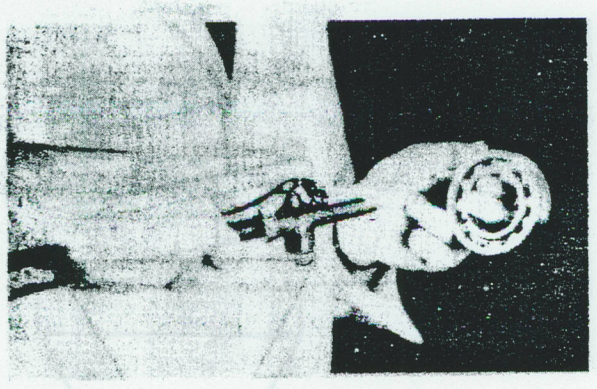


FIGURE #39

ADAPTER TO GUIDE AND RESTRICT THE FLOW OF LUBRICANT TO THE OPENING IN THE BEARING SHIELD.

CAUTION

The air must be free from dirt or moisture.



Caution - Read Before Doing This

A blast of air can blow dust into assemblies and cause trouble. Use hose carefully, in a clean location and as directed here. Never allow air pressure to spin a bearing. Look out for water and dirt in air line.

FIGURE 40

sufficient lubricant is applied to the bearing raceways.

3. Roller Substitution. If one or more of the rollers in a cylindrical roller bearing are not fit for further use (see Figure 41) substitute another new or used roller providing the tolerances are within the wear tolerances of the respective rollers in the used bearings. Careful consideration should be taken that the roller substitution is accomplished so that rollers of a similar manufacturer, bearing and part number are incorporated. Most roller bearings are easily disassembled and in no case should any of the rivets be removed to accomplish an interchange of rollers. Rollers that are held in the cage by means of a wedge type retainer construction can be removed by inserting the retainer assembly in a vice so that the jaws (brass) will clutch one roller. The force of the bearing weight will pull the roller out of the retainer assembly. With one roller removed the rest of the rollers can be removed with ease.

NOTE: The individual rollers can be gaged on the Shadow gage used for checking the O.D. dimension of bearings. It is advisable to maintain a stock of used rollers on hand.

4. Retainer Substitution. Cylindrical rollers bearings usually have solid bronze cages and these retainers can be interchanged providing retainers of the same style, manufacture, and size are interchanged. Extreme care should be used in order to check lateral bind in retainers as sometimes this will even occur in new bearing production. A stock serviceable retainers should be on hand and properly marked so that the interchange can be made possible. The rejected bearings which have good

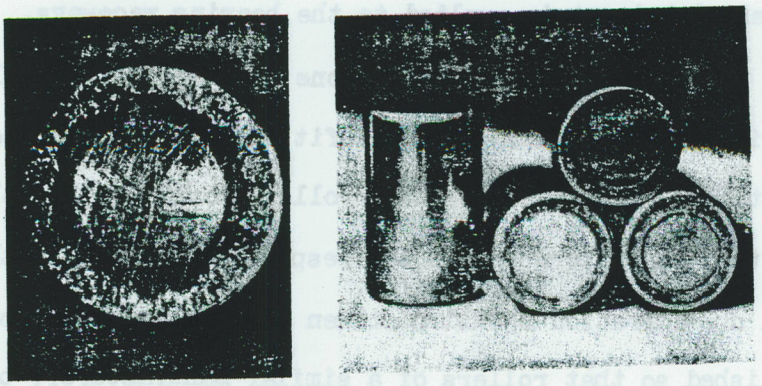


Figure 41
Smearing on Roller Ends

solid bronze or brass retainers should be disassembled providing no rivets are removed and the good retainers held for future use.

4a. Ring Substitution. The rings, outer and inner, of demountable Anti-friction Bearings may be substituted, as necessary. Use an interchangeable, serviceable ring of the same manufacturer, size, part and dash number, provided the assembled bearing meets original tolerance specifications. Rings for substitution may be accumulated in the Bearing Branch and are not normally procurable as separate parts. Ring substitution should not be made if the unserviceable ring to be replaced is condemned because of a fatigue failure. In this case, the remaining ring may be presumed to be approaching the ultimate of its fatigue life and the entire bearing should be condemned. When pivot ball bearings are reinstated they do not necessarily require installation on the same pivot from which they were removed. Tapered roller bearing components may be similarly interchanged; serviceable "Magneto" type bearing component assemblies may also be interchanged.

5. The factors outlined above are general considerations which apply in the broad use to anit-friction bearings. Special considerations are involved in specific applications and functional requirements will be provided for when detailing proper inspection procedures for particular types of equipment when necessary research and experiments can be accomplished. It should be understood that the purpose of bearing inspection in bearing maintenance departments is to assure that the bearings returned to service are a good risk for satisfactory operation throughout the next overhaul period. Bearings have a longer life expectancy than the total sum of the hours of actual operation in respective equipment. Hence, usually when a bearing is removed at overhaul, it really has only operated for a relatively short period compared to its overall life expectancy. Bearings will be rejected when failure is evident or when conditions conducive to failure per the above policy are present. Aside from significations of this type, the bearing should be thoroughly cleaned, inspected and returned to local issue with the full understanding that it is not required to have the high finish and unblemished appearance of a new bearing.

6. Cause of Bearing Failures. Figure 42. Anti-friction bearings of the ball or roller type are employed in aircraft equipment because of the relatively high degree of efficiency and reliability which they demonstrate in service. Such bearings operate by supporting the load on rolling contacts of balls and rollers in hardened steel raceways and are not dependent on an oil film to carry the applied load. It can be noted

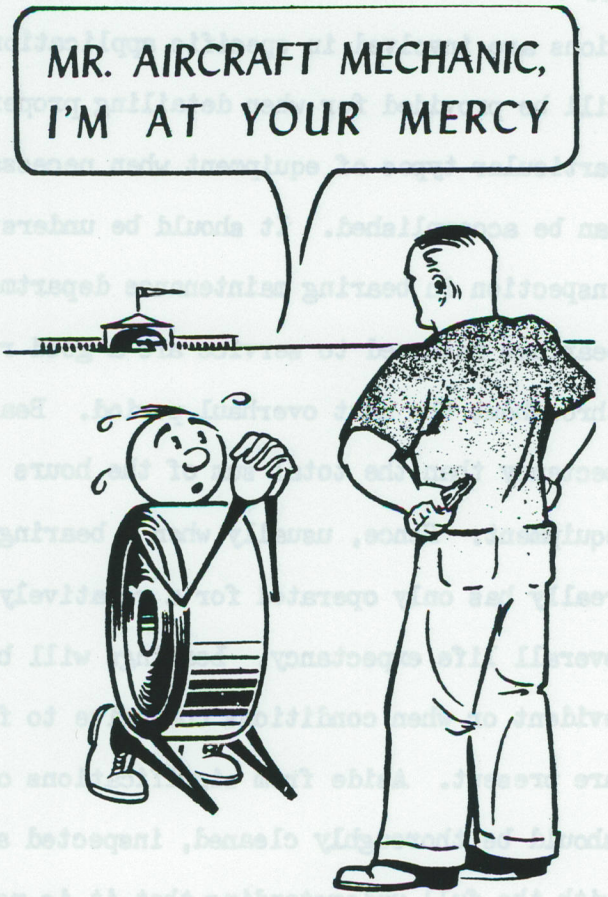


FIGURE 42

here that lubrication used in conjunction with ball and roller bearings operation is of value insofar as conducting heat from the friction aroused by the metallic contacts is concerned. Because of this feature their performance is less critical under circumstances of overload and variation in lubricant.

7. Experience in maintenance of bearings has shown that they have certain characteristic types of failures, the occurrence of which is largely determined by incorrect conditions of installation. The understanding of such failures is important in determining the service which can be expected from a bearing in the bearing maintenance department. The following common causes of bearing failures are listed in order to coherently relate the cause of failure to the physical characteristics present in the bearing.

a. Improper fitting of the bearing at installation due to incorrect dimensions or out-of-roundness of the shaft seat or housing will either bind the bearing causing excessive wear or will permit the external surfaces of the bearing to creep.

b. Misalignment resulting from errors in installation or from deflection of actual rotating parts under loads will cause the bearing to rotate out of circumference and will develop an eccentric track on the raceway.

c. Improper internal clearance due to incorrect installation within the bearing results in a preload and overload condition and will create maximum friction. This will cause excessive wear plus an overheating condition. Balls and rollers which have a blue cast are usually subjected to this condition.

d. Insufficient or incorrect lubrication will permit the bear-

ing to operate under high temperature and consequently, create a discoloration of the bearing's component parts. Bearings of this nature should be rejected due to the change of their molecular state.

e. Inadequate provisions for sealing and protection of the bearing from the destructive action of foreign matter, moisture, and corrosive reactions set up a breakdown of the surface structure. Bearings should be rejected which indicate such evidence.

f. Abuse of the bearing by improper handling at installation or overhaul may result in any number of conditions previously mentioned which will make it necessary to reject the bearing.

g. Abnormal operating conditions, such as the passage of electric current through the bearing, excessive vibration or damage due to the failure of other parts of the assembly are basis for rejection.

h. Defective material or workmanship in the manufacture of the bearing will usually show up at first overhaul and no attempt should be made to process bearings. See Figure 43 and 44.

8. In the absence of any of these causes of failure, anti-friction bearings can be expected to attain the life expectancy of the equipment. This life is determined by fatigue deterioration which develops progressively in service and is due to respective contact stresses occurring under loads. Suitable fatigue life as designed originally into the bearing and the end of a bearing's fatigue period is finally made evident by flaking of the raceway surfaces. Inspection of the bearing at overhaul, therefore, should be such as to discover any evidence of failure and to detect any condition that is indicative of incipient failure.

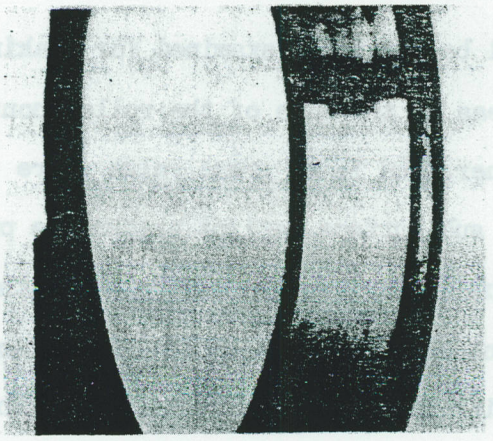


FIGURE 43

Defective Material

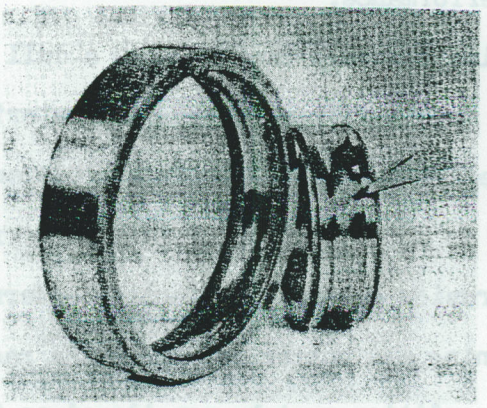


FIGURE 44

Defective Material

9. Power Plant Bearings.

a. Cylindrical roller bearings used as main bearings on radial engines are particularly subject to fatigue on the inner raceway. This is due to the localized character of the load. The roller path of the inner race should be carefully examined for flaking or fatigue cracks, especially in the areas at the edge of the roller contact. Magnaflux inspection of the inner race is of great value where there is a doubt to determine whether sub-surface fatigue cracks are present.

b. The dulling evident on the roller paths and roller surfaces, due to fragment denting, is a typical condition and is to be expected in any bearing that has been in service. This condition is usually harmless and can be ignored except when the bearing has been operated with a hard, sharp abrasive, such as sand, present in the lubricant; in this case the fragment denting is severe and appears as sharp indentation similar to corrosion pitting. In this case bearings will be rejected. See Figure 45.

c. The circumferential scratches, frequently noted on raceways and rollers, are due to the passage of foreign matter through the bearing. This condition is unsightly, but ordinarily is harmless in its effect on performance.

d. Engine bearings usually show a dull gray cast on the raceways. This is a thin film of carbonized material which is difficult to entirely remove in cleaning. This appearance is normal and can be disregarded as an indication of failure or rejection.

e. Corrosion and rust, affecting external surfaces, can be removed by cleaning and polishing. When the raceways and rollers are involved, the condition must be considered as to degree of severity.

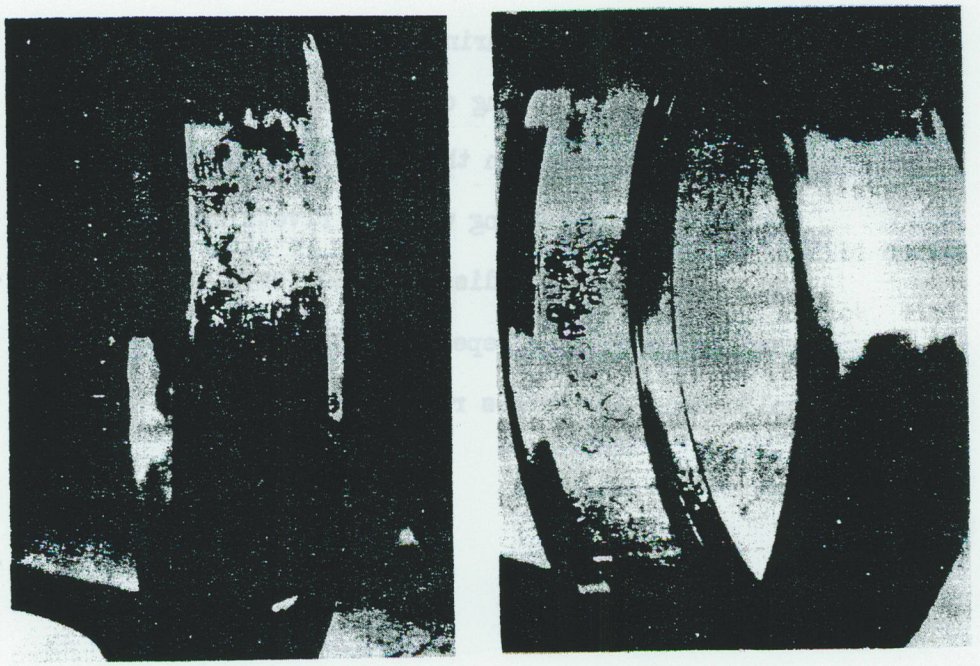


FIGURE 45

Pitting Due to Abrasive

Reaction

NOTE: No ball or roller bearings should ever be disassembled for cleaning or rework unless there are no rivets or tangs on the bearing retainer. A seperable type bearing without rivets or tangs in the retainer can be disassembled for cleaning and rework. Usually a seperable type bearing uses a solid bronze or brass retainer or cage.

Discoloration and tarnish are harmless in themselves, but may be the indication of more serious effects in localized areas. Corrosion attacks the load carrying surfaces while the bearing is stationary and there is a tendency for the action to concentrate in the meniscus adjacent to the roller contacts. The severity is judged by the occurrence of pits and their depth and distribution with regard to the load path on the raceways and rollers. Deep pits closely grouped in localized areas serve as stress raisers under load and will accelerate fatigue action and flaking. This is especially true where the load is concentrated on a part of the raceway, rather than being distributed. This is cause of rejection. Pitting, resulting from a mild corrosive condition, appears as a shallow and widely dispersed attack, similar to fragment denting, and will not be important in its effect on performance.

f. Loosening of the inner race on the crankshaft bearing seat may lead to serious contact corrosion in the bore and pitting of the shaft. This condition may be the result of "growth" of the inner race due to high operating temperature in service. Bearings showing growth should be carefully checked for internal radial clearance, and also for bore size before reassembly in the engine.

g. Crankshaft bearings fitted with the one piece type of cage can be completely disassembled for inspection. The land surface of the race serving to center the cage should be clean and polished smooth, if necessary, in order to prevent a tendency to pick up or seize in service.

h. The spacer mounted with the inner race will sometimes show galling and contact corrosion on the faces in contact. This condition should be corrected by smoothing and polishing before reassembly.

The same thing is true of the outside diameter fitting in the bore of the crank case liner.

10. Propeller Thrust Bearings.

a. These are ball bearings and are either of the non-separable or separable type. Effort should be made to thoroughly clean the parts prior to inspection. In the case of the non-separable type, a dark box with built-in light and reflector greatly facilitates inspection of the raceways. The bearing should be repeatedly rotated by hand in order to make a thorough examination of the surfaces of the balls.

b. The separable type, or three-piece bearing, can be more readily examined and a magnaflux inspection can be made on the races if necessary. Care must be taken not to interchange parts with those of other bearings.

c. Propeller thrust bearings are particularly subject to corrosion as a result of moisture entering through the nose plate seal or from crankcase fumes condensing on the exposed bearing surfaces. Pitting of the raceways or balls is more serious than in the case of roller bearings and should always be regarded as a potential cause of fatigue failure. Deep pitting closely grouped in the load path of the raceway should be considered as cause for rejection. See Figure 46. Tarnish and light surface corrosion can be safely removed by polishing or buffing.

d. Flaking, when present, will always be found in the load path on the raceways or on the surface of the balls. Any evidence of flaking is cause for rejection.

e. Where external surfaces have galled and picked up from

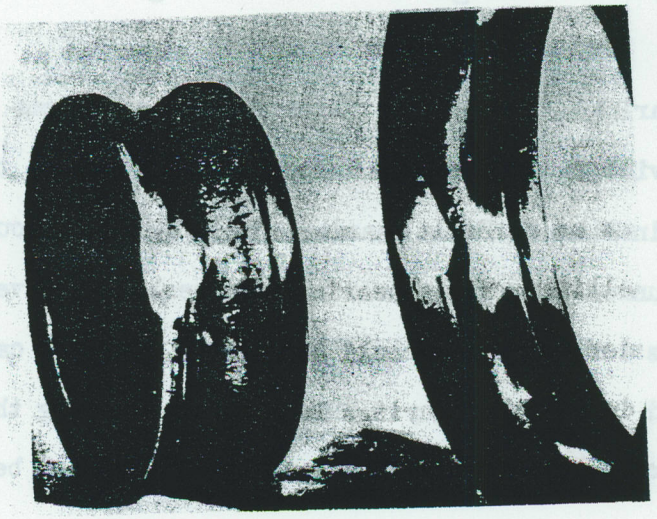


FIGURE 46

Severe Pitting Due to End Thrust

and Fatigue

mating surfaces in the mounting, correction can be effected by smoothing and polishing in the bearing maintenance department.

f. In some cases the bearing may be damaged as a result of "smearing" between the balls and the retainer. Material is picked up on the surface of the balls due to a highly localized welding action and the surface presents a very spotty and roughened appearance. The smearing accelerates fatigue and should be regarded as cause for rejection.

11. Rocker Arm Bearings. Rocker arm bearings tend to become rough and sticky in service as a result of accumulated carbon and the development of false brinelling. These bearings after being thoroughly cleaned by hot solvent under pressure should be serviceable with very few rejections. This is due to the bearings large load carrying capacity plus its extended life expectancy. Fixtures for cleaning the ball and roller type rocker arm bearings being designed and will be released shortly.

a. In inspecting these bearings, a thrust pressure should be exerted by hand on the inner race, and the outer race should be rotated by hand allowing the bearing to coast. A sudden stop will indicate that the bearing is either rough, brinelled, or dirty, It is not necessary to remove the seals from rocker arm bearings in order to properly clean the bearing due to the fact that provisions are made in the inner and outer races to release foreign matter and oil present in the bearing. However, it is essential to remove the bearings from the rocker arm assemblies.

SECTION XIII

TABLE OF LIMITS

XIII. Table of Limits.

1. Explanation:

a. Bearings are designed and manufactured with certain tolerances which are carefully controlled by the manufacture. Each component part of an anti-friction bearing is accurately gaged so that when the bearing is completely assembled, the proper limits and tolerances are incorporated. Bearings subjected to normal operating conditions do not wear appreciably beyond new tolerances and hence, the original tolerances are not effected.

b. In certain installations bearings are subjected to abnormal operating conditions and such bearings will be termed "Select Bearings." As soon as possible table of tolerances will be established on these bearings.

c. Until such data can be compiled inspectors will be governed by the standards which are used at present or by the standards comparable to new bearing design.

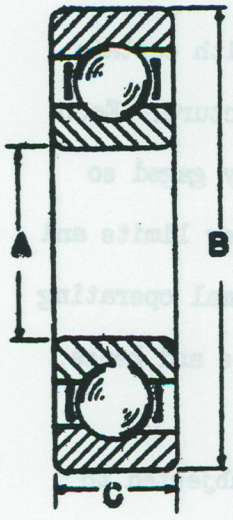
2. Selected Bearings:

a. Supercharger Bearings:

(1) The following page lists the correct Radial and End Play for these bearings.

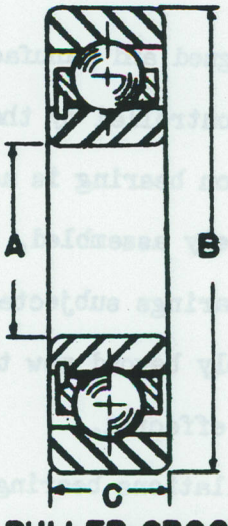
Selected Supercharger Bearings

FIG. 1



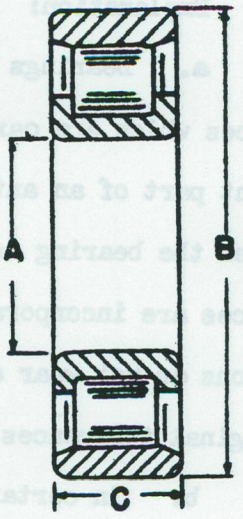
BALL BEARING
G-E DWG. P-6651923

FIG. 2



PULLER GROOVE
BALL BEARING
G-E DWG. P-8438764

FIG. 3



ROLLER BEARING
G-E DWG. P-6651922

TABLE NO. 1
Manufacturers' Dimensions and Allowable Tolerances

Type Super-charger	Fig. 1			Fig. 2			Fig. 3		
	A	B	C	A	B	C	A	B	C
B	1.1811 +.0000 -.0002	2.8346 +.0000 -.0003	.7480 +.0000 -.0050	1.1811 +.0000 -.0002	2.8346 +.0000 -.0003	.7480 +.0000 -.0050	1.1811 +.0000 -.0002	2.8346 +.0000 -.0003	.7480 +.0000 -.0050
C	1.5748 +.0000 -.00025	3.5433 +.0000 -.00035	.9055 +.0000 -.0050				1.5748 +.0000 -.00025	3.5433 +.0000 -.00035	.9060 +.0000 -.0050
D	1.3780 +.0000 -.0002	3.1496 +.0000 -.0003	.8268 +.0000 -.0050				1.3780 +.0000 -.0002	3.1496 +.0000 -.0003	.8270 +.0000 -.0050

TABLE NO. 2
Overhaul Tolerances

Supercharger Type	B	C	D
Radial Play Ball Bearing	.0007	.0008	.0007
End Play Ball Bearing	.0090	.0110	.0100
Radial Play Roller Bearing *	.0010	.0010	.0010

* No Roller Bearing with less than .0004 Radial Play shall be used.

SECTION XIV

INTERCHANGEABILITY LIST

XIV. Interchangeability List.

1. Data for this subject is being compiled and will be released shortly. This information is intended to assist the bearing maintenance department in placing the proper nomenclature on the bearing package before it is dispatched to local issue. Serviceable bearings leaving the bearing maintenance department will have the proper class number, Air Forces stock number and part number stenciled on the outside of each package.